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DEVELOPMENT OF BACKWARD COUNTRIES

PROF. A. V. HILL'S presidential address to the British Association should dispel any facile optimism as to the ability of science and technology to increase the world's food supplies—or to develop world resources generally—sufficiently rapidly to overtake the demands of a rapidly increasing world population. Whatever view is taken of the possibility of controlling the expansion of population, there can be no doubt as to the urgency of expanding as rapidly as possible, and with regard to long-term at least as much as to short-term needs, the world's food supplies, and developing world resources with equal regard to such long-term requirements rather than immediate exigencies. So far as Britain is concerned, when all that is possible has been done to improve the efficiency of food production and to remove waste—whether due to the destruction of crops in the field, or in transport or storage—the largest hope for increased production lies in the more backward countries. Only as the standards of cultivation are raised in those areas and the fullest use is made of available knowledge can there be any hope of raising the standards of living in those countries, or of making any contribution to the needs of the rest of the world.

Two recent broadsheets by Political and Economic Planning dealing with technical assistance have thus appeared at a time when Prof. Hill's address has directed general attention to a most important topic. The first of these broadsheets (No. 346) deals with agencies and programmes ; the second (No. 347) with policy and method. Both, however, are in direct sequence of an earlier broadsheet (No. 340. "The World's Food." April 7, 1952), which itself continued a discussion initiated in "Prospect of a Decade" (No. 328) and "The Strategy of World Development" (No. 327). They reiterate warnings already given, and bring to the examination of these problems the same sense of urgency and realism as characterizes Prof. Hill's address.

Much of the broadsheet "The World's Food" was occupied by a discussion of three recent books on world population and food supply which have attracted considerable attention. The view is accepted that unless starvation and malnutrition are to become very much more serious even than they are now, food supplies in many parts of the world will require to be more than doubled in the next fifty years. The earlier estimate, in "Prospect of a Decade", that less than three per cent of the earth's acreage is more or less satisfactory for the support and shelter of mankind is now regarded as too pessimistic ; but in reviewing the possibilities of increasing the area of land devoted to food production or increasing the production from a given area of land, P E P emphasizes the strong temptation in the present situation to farm for the greatest immediate yields, at the risk of reducing the fertility of the soil and exposing it to erosion.

If the human race continues to multiply at the present rate, catastrophe will only be avoided if methods of cultivation are used which, far from

destroying the fertility of the soil, maintain or even increase it. Nor will it be possible to countenance the continuance of laws and customs regulating inheritance which in some countries lead to a fragmentation of land holdings and the prevention of efficient methods of cultivation. It is true that a limited number of people from the over-crowded areas of the world could feed themselves better if they were allowed to migrate to much less intensively settled areas; but apart from this, more food for the poorer people of the world means, for all practical purposes, more production in the areas where they live.

Here we are led to the question of technical assistance. Such increased production depends at first on the technically advanced countries providing the cost of such assistance and equipment. They must also assist by teaching improved methods of cultivation. Moreover, there is the question whether, even by such improved methods, sufficient food can be grown for all the peoples of the world without decreasing the land available for crops which are wanted by advanced countries as a source of raw materials for their industries. As population increases, it may become increasingly difficult for the richer countries to maintain or improve their standards of living without depressing people in other parts of the world below the subsistence level.

It is, of course, possible that the amount of cultivable land or the yields which can be obtained without exhausting fertility will prove to be considerably greater than can be safely predicted. Even if, however, the rate of growth in the world's population decreased sharply and sooner rather than later, or the use of novel sources of food gave greatly increased supplies, it is improbable that a clash of interests between the richer and the more backward parts of the world will be entirely avoided. Plans for technical assistance must, as P E P wisely insists, take full account of such possible conflict if they are to be realistic and effective, and must aim at reducing the clash or tension as much as possible.

The importance of this factor is well brought out in the two broadsheets on technical assistance. The first recognizes that some such areas may be able to develop their economy from their own resources, provided they can secure the highly trained men from outside to teach the new techniques and secure their adoption, and emphasizes the multiplicity of agencies at present available to supply such assistance. Even so, the importance of confidence is not obscured. Unless the government of the backward area can be trusted to honour its undertakings, the schemes break down, and men of integrity and ability are unlikely to be forthcoming.

Technical assistance provided through the specialized agencies set up under the United Nations, which is co-ordinated through the Technical Assistance Board, is provided only to, and at the request of, the government concerned, though many of the governments needing technical assistance require also to be helped to formulate reasonable requests. Such technical assistance is not to be used as a means of economic or political interference, and it is also laid down that the experts provided should possess some understanding of the needs, aims and social and cultural background of the country they are sent to assist. Normally, also, governments requesting assistance are expected to assume responsibility for a substantial part of the cost of the technical assistance provided.

Under such international agencies, 797 experts were recruited for under-developed countries by the end of 1951; of these, 271 were provided through the Food and Agriculture Organization, 155 through the World Health Organization, 109 through the United Nations Educational, Scientific and Cultural Organization, 65 through the International Labour Organization and 32 through the International Civil Aviation Organization. There are no figures to indicate the distribution of experts by activities or areas; but besides the technical assistance afforded in this way there is also that provided through the bilateral programmes of individual advanced countries, such as the United States Point Four programme and the British schemes promoted by the Colonial Office. Thirdly, there are the regional agencies and programmes exemplified by the Colombo Plan Council for Technical Co-operation, the Pan-American Union and the Inter-American specialized agencies, and the regional economic commissions for Asia and the Far East, and Latin America, set up by the Economic and Social Council of the United Nations, though the latter regional commissions have much broader functions as well.

By January 1952, under the Point Four programme, general agreements had been made with more than thirty governments, and some 619 United States technical experts were in the field; this figure had risen to 972 in thirty-three countries by June 30, 1952. Further, at the end of 1951, some 372 persons from other countries were receiving training in the United States under the Technical Co-operation Administration. Besides the 35 million dollars appropriated for the Point Four technical assistance programme in the year ending June 30, 1951, the United States also contributes to technical assistance through such other means as the Fulbright Training Scheme, the Rockefeller Foundation and the Near East Foundation.

No comprehensive account of British technical assistance in the Colonies is available, and although the P E P broadsheet estimates expenditure on this as approaching £8 millions for the year ending March 31, 1952, no estimate is given of the demand made for staff. No such estimate was attempted, it may be recalled, in the House of Lords debate on this question last May, when Lord Milverton quoted a figure of 150,000 for the annual output of trained men in the Commonwealth centres of South and South-East Asia. Under the Colombo Plan, however, only 45 out of 177 experts requested were secured in 1951, and only 309 trainees were placed out of 781 proposed. The Plan set a maximum of £8 millions, for technical assistance to be given in the three years from July 1, 1950; but by the end of 1951 expenses and commitments totalled no more than £400,000, and in general the Colombo Plan Council has concentrated on the supply of those types of technical assistance which are not available from other sources.

The first of these broadsheets thus illustrates the need for co-ordination between the numerous agencies concerned with technical assistance—a need which is fully recognized. Of requests for 242 experts made under the Colombo Plan up to the end of 1951, 65 were withdrawn, and out of 833 requests for places for trainees, 52 were withdrawn, mostly because the requests had been met through other channels. The fourth report of the Technical Assistance Board stressed the need for avoiding duplication of effort and competition between the programmes which recruit experts and use training facilities in the same countries. "Wide divergencies in the salary scales and allowances of experts or stipends of fellows, and notable differences in the contributions expected from under-developed countries to the local costs of projects under the different programmes can," the report observes, "seriously embarrass and slow down operations."

The Technical Assistance Board is endeavouring to mitigate the effects of any such competition by arranging exchange of information on administrative practices between the various bodies concerned; but there is general agreement that the main task of co-ordination must be undertaken in the under-developed countries themselves. Here, especially, the giving of technical assistance is bound to be a matter of considerable delicacy. In some under-developed countries, P E P frankly points out, economic progress may be impossible while the existing methods (or lack of methods) of government and tax collection remain. Such countries may be said to need technical assistance in reforming their government organization; but they may not welcome it, and meanwhile their imperfect standards hinder alike the co-ordination of technical assistance and the recruitment of experts. The latter, as the first annual report on the Colombo Plan emphasized, is by far the most difficult part of any scheme for technical co-operation.

To secure the services of the right kind of men is probably the most important single factor in the success of technical assistance. To this factor this second P E P broadsheet gives the attention it deserves, though the analysis is qualitative rather than quantitative. P E P does not consider the relation between what it terms the present 'infantile' demands of the technical assistance programmes for personnel and the shortage of scientific and technical man-power already existing in the United States and in Great Britain, for example. A present total of 2,500 or more experts is by no means a negligible drain on man-power resources, even if it were not expected to grow considerably.

If, as is rightly emphasized, the under-developed countries are insistent on demanding able men of established reputation and, at the same time, it is desirable that the experts supplied should be not only technically competent, but also able to apply their knowledge in the circumstances of an under-developed country or train people of very different backgrounds, it must be remembered that for such men there may be a great demand. Remunerative posts are likely to be available in their own countries, and it is not easy at best to induce them to transfer to the comparative discomfort of the backward areas. Some sense of vocation or call to disinterested service may be an essential motive, and undoubtedly would be the ideal. Integrity and tact, in fact, are as important as skill and ingenuity, for if technical assistance is to achieve its purposes, a new attitude of partnership must be fostered.

Political and Economic Planning has done well in this broadsheet to stress the critical importance of the technical expert and the need for careful training as well as selection, and it is welcome news that the Technical Assistance Board of the United Nations is studying methods of briefing experts both on the technical aspects of their assignments and on the social and economic conditions of the countries to which they are to be sent. The Institute of Social Studies, established by the Netherlands Universities through the Foundation for International Co-operation, also gives training and conducts research in matters relevant to technical assistance.

There are other factors which bear on this question of obtaining the right type of technical expert. The good conditions of service which it is essential to offer are related to the policy of requiring technical assistance to meet certain local costs. While this is sound from the point of view of stimulating interest and responsibility on the part of the receiving countries, such a policy can cause real hardship. One possible suggestion mooted in the P E P broadsheet is to institute some sort of deferred salary scheme. This might mitigate some of the disparity in standards of living, but admittedly it might fail to attract the very men whose assistance is most desired.

Insufficient experience is yet available for a sound judgment on such points as these. Other thorny problems are provided by the supply of equipment and of capital for development, while even more difficult are those that arise in regard to priorities and the balance of programmes. Officially the aim is still to provide assistance to all countries which request it, while allowing each country the final decision on the purposes for which it requires assistance. Nevertheless, as requests for technical assistance outrun the resources at the disposal of the various agencies, the danger may grow that technical assistance will be spread too wide and thinly to do any real good anywhere.

These and other questions are faced realistically in these broadsheets, which make no attempt to disguise the dangers which may attend the attempt to distribute assistance wisely and altruistically rather than in response to pressure of any kind. On the whole, the survey leaves room for hope. Instances are cited to illustrate the far-reaching effects of quite small projects launched with imagination and conducted with sympathy by the right type of expert. The emphasis on quality in technical assistance is already justified by experience as well as by theory; but if the right schemes are to be selected and launched at the right level, if they are to be staffed by men and women of the calibre desired, and carried through to success with imagination and understanding, unceasing scrutiny and vigilance will be required.

Ultimately much must depend on the interest taken in technical assistance by the scientific man and technologist. Clearly any proposals for a Commonwealth or international technical service should engage the close attention of their professional associations, to ensure that satisfactory conditions of service are laid down. Clearly, too, if the demands which technical assistance makes on trained man-power in Britain and in other advanced countries are to be accepted, steps must be taken to ensure that the limited man-power available is not wasted on projects which offer little prospect of success, whether through political, economic or technical reasons. It is perhaps through imaginative and sympathetic selection of enterprises, rather than grandiose schemes for new international agencies with financial resources geared to military expenditure, that the backward areas will be able to develop the resources which will both raise the standards of living for their own peoples and minimize the dangers to which the demands of increasing world population expose the whole world.

STABILIZING SELECTION IN EVOLUTION

Factors of Evolution

The Theory of Stabilizing Selection. By I. I. Schmalhausen. Translated by Isadore Dordick. Edited by Theodosius Dobzhansky. Pp. xiv+327. (Philadelphia: The Blakiston Company, 1949.) 6 dollars.

ALTHOUGH I. I. Schmalhausen's book appeared in Russian in 1947, and in an American translation as long ago as 1949, it has received rather little attention in Great Britain, and it still seems worth while to review it. It is a ponderous work, written in a style which, one suspects, was even before translation heavy and repetitious, and the translator has not succeeded in making it easy to read. But the labour brings rewards. The book contains accounts of most of the recent experimental and theoretical work on the genetical mechanisms of evolution; but it is not in this that its main value lies: indeed, better summaries of this material will be found in the well-known monographs of Dobzhansky, Huxley and others. Schmalhausen provides rather fuller references than most such publications to recent Russian work, which is not so accessible, and this already gives his book certain distinctive usefulness.

The main value of the work, however, lies in the particular point of view which Schmalhausen has derived from his studies as an embryologist, and which differentiates him from most of the other recent writers on evolution. He makes a consistent attempt to envisage the evolving animal, not as a mere adult form, nor as an assemblage of genes, but as a developing being characterized by a certain norm of reaction to its surroundings. This leads him to emphasize the conservative role of selection. He lays stress on the distinction between 'dynamic selection', which brings about changes in the animals' submitted to it by favouring certain new types, and 'stabilizing selection', which perpetuates the norm by eliminating deviants. He points out that stabilizing selection does not merely conserve the *status quo*; it will actually entrench the prevalent and well-adapted norm, rendering its development more stable and less responsive to disturbing influences. It would have made Schmalhausen's thought clearer if he had distinguished these two aspects, both of which are included in his use of the term 'stabilizing selection'; as Simpson has pointed out in a review in the *Journal of Heredity*, it is also used in still other different senses.

Schmalhausen directs attention to the importance of stabilizing selection as a mechanism for the evolution of adaptations. He suggests that an originally variable but adaptive response to an environmental stimulus may become stabilized and will then eventually arise autonomously—that is, by heredity. Owing to the lack of precision of the general phrase 'stabilizing selection', it is not easy to make quite certain how Schmalhausen envisaged the passage from the 'acquired' to the 'inherited' status of the character. Sometimes he seems to be thinking along the lines of the theory of 'organic selection', suggested some fifty years ago by Baldwin, according to which an adaptive environmental response acts by enabling a species to occupy an otherwise unsuitable niche until such time as a mutation turns up which endows it with a hereditary adaptation. In other places he seems to imply, but perhaps never quite clearly states, what is surely the more fruitful suggestion, that if a response to an abnormal environment becomes stabilized in the sense of being rendered less susceptible to disturbing influences, this means that it will be less easily abolished when the abnormal environmental influence is removed, and will in this way pass from being dependent on the environment to being relatively independent of it. Similar ideas were put forward in a short article by me, using rather different terminology, at about the same time as Schmalhausen's book first appeared; but in this latter work they have received for the first time a full-length discussion against the background of the relevant embryological, genetical and evolutionary facts.

C. H. Waddington

PROBLEMS AND POSSIBILITIES IN FOOD TECHNOLOGY

Advances in Food Research

Vol. 3. Edited by E. M. Mrak and George F. Stewart. Pp. xii+518. (New York: Academic Press, Inc., 1951.) 9.50 dollars.

THIS, the third volume of "Advances in Food Research", presents monographs on ten subjects. References, which total about fourteen hundred, usually bring information up to 1950; early work, however, is not neglected.

Two papers relate to discoloration of foodstuffs. M. A. Joslyn and J. D. Ponting deal with enzyme-catalysed oxidative browning of fruit products, which may be a serious problem to the manufacturer when fruit requires peeling or slicing. The varied enzyme systems involved are discussed, and suggestions for controlling the trouble in manufacture are put forward. The well-known 'browning' reaction which discolours products such as condensed milk is considered by J. P. Danehy and W. W. Pigman in an article on reactions between sugars and nitrogenous compounds and their relationship to certain food problems. The aldehyde–amine reaction is followed from its simplest form to the production of melanoidins and of protein-saccharide compounds. It is suggested

that 'browning' is extremely complex in character and dependent upon specific reactant conditions.

Three papers deal with microbiological matters. In one on chemical and microbial studies on sliced canned bacon, John A. Ulrich and H. O. Halvorson deal with the keeping problems presented by a non-sterile food produced by an old empirical process. They make practical suggestions for improving the keeping quality and favour the addition of *nor*-dihydroguaiaretic acid as an antioxidant—a procedure which in Great Britain would appear to be contrary to the Preservative Regulations. Mathilde von Schelhorn, dealing with the control of micro-organisms causing spoilage in fruit and vegetable products, covers a wide range, embracing, among other aspects, preservation by heat and cold; sterilization by filtration; preservation by chemicals and by fermentation; and the use of fungicidal wrappings for fruit. She stresses the influence of low initial infection and clean handling in lengthening the life of fruit and vegetable products. A subject of recent concern is presented by W. R. Hinshaw and Ethel McNiel in their review of Salmonella infection as a food industry problem. The incidence and importance of Salmonella poisoning are discussed, and procedures for the isolation and identification of the organisms are described. Methods of control are proposed.

In view of the great recent concern both in Britain and in the United States about the addition of chemicals to food, many readers will turn with special interest to the article, by A. J. Lehman, O. G. Fitzhugh, A. A. Nelson and G. Woodard, of the Food and Drug Administration, Washington, D.C., on the pharmacological evaluation of antioxidants. Reference is made to a paper by Lehman giving a general plan of pharmacological investigation which permits a thorough appraisal of any proposed addition to food. Both acute and chronic toxicity are discussed. Figures are given (many of them previously unpublished results of the Food and Drug Administration) for the comparative toxicity of numerous materials which are recognized as possessing antioxidative value. It is claimed that safety in use has been demonstrated for propyl gallate, thiodipropionic acid and its dilauryl and distearyl esters, and for gum guaiac.

The problems involved in the preparation and storage of dried milk are discussed by S. T. Coulter, Robert Jenness and W. F. Geddes in their paper on the physical and chemical aspects of the production, storage and utility of dried-milk products. Particular attention is given to deterioration on storage. It is pleasing to note that in the extensive bibliography many of the important papers on milk powder which have appeared in the *Journal of Dairy Research* receive mention.

The article by Bernard E. Proctor and Samuel A. Goldblith, on electromagnetic radiation fundamentals and their applications in food technology, deals perhaps with possibilities more than with applications, though such well-established techniques as ultra-violet and infra-red spectroscopy and X-ray diffraction are touched on. Varied suggestions are mentioned for applying electric fields and radiations and electron beams in food technology. Possibly the most immediately valuable of the techniques described is that of radio-frequency heating. The rapid generation of heat inside a material opens up wide possibilities.

R. R. Hartwell's article dealing with certain aspects of internal corrosion in tin-plate containers is a wide survey of this complicated subject. Almost all possible factors in corrosion are considered, including the nature of the contents, variations in canning practice, thickness and continuity of tin, and characteristics of the steel base. Hartwell attaches much importance to the last-mentioned factor. In rationale for studies of consumer food preferences, Richard L. D. Morse deals with a subject of which little is heard in the United Kingdom. The British reader will find much of interest in this monograph, with its suggestion that the subject is related to "psychology, anthropology, statistics, economics, food technology, nutrition, and marketing".

This book is recommended as of interest to all food chemists and technologists. It should prove invaluable to those carrying out researches on the subjects treated.

A. T. PARSONS

FRESHWATER LIFE OF THE BRITISH ISLES

The Freshwater Life of the British Isles

A Guide to the Plants and Invertebrates of Ponds, Lakes, Streams and Rivers, with an Additional Chapter on the Vertebrates. By John Clegg. (Wayside and Woodland Series.) Pp. 353+57 plates. (London and New York: Frederick Warne and Co., Ltd., 1952.) 21*s*. net.

THIS book is a worthy addition to the "Wayside and Woodland Series", and it conforms to the handy size and high standard of illustration for which the Series is well known. After an introduction and a chapter on "Life in Freshwater", Mr. John Clegg goes through in turn the various major divisions first of the plant and then of the animal kingdom, describing briefly those members of each group which inhabit the fresh waters of the British Isles. Next come a useful chapter on the collection and examination of specimens, one on freshwater biology in the service of mankind and two short appendixes dealing respectively with hydrogen-ion concentration and with anglers' names for aquatic insects. The brief bibliography is arranged by taxonomic groups and serves to introduce the reader to the most important literature on each, especially taxonomic works; the index refers to text-figures and plates as well as letterpress.

The introductory matter is excellent, clear without being unduly over-simplified, and interestingly written while yet being terse and full of facts. The beginner is here provided with an admirable introductory survey of the physical and chemical properties of the freshwater environment and the physiological demands which they make of aquatic animals.

The central chapters make no attempt in most groups to enable the reader to identify his captures with precision (this would be out of the question in a book of this size), nor are any artificial keys provided. Nevertheless, anyone who has studied it carefully should be able to form a fair idea of the zoological position of any ordinary freshwater plant or animal, even to the genus in a good many cases. This part of the book strikes a zoologist as written very much in the traditional manner of a zoological text-book. In so far as the book is intended to convey zoological facts to the beginner in the subject, this is perhaps no disadvantage; but it is possible that the adoption of a more ecological point of view would have made the book more interesting.

In the illustrations, of which most are good and many outstanding, the author has made good use of his skill with his camera and microscope. One cannot help feeling that some must have lost certain of the finer detail and acquired excessive contrast in the process of reproduction. It seems a pity, also, that some of them have been reproduced quite so small.

The publisher says that the book "is intended for those generally interested in the subject, as well as for the more serious student". For the former of these groups it should prove a useful handbook; for the latter a sound introduction which, however, they will outgrow before long. Mr. Clegg is to be congratulated on having done a difficult job with a very considerable measure of success. H. C. Gilson

INTRODUCTION TO QUANTAL STATISTICS

Éléments de physique moderne théorique

Par Georges Guinier. (Bibliothèque de la Science moderne.) 3: Statistiques quantiques. Pp. 313–488. (Paris: Libr. Bordas, 1951.)

THIS book, the third and final volume of Prof. G. Guinier's "Éléments de physique moderne théorique", being largely independent of the preceding parts (which dealt chiefly with the quantum mechanics of atoms and molecules, see *Nature*, June 14, p. 983), forms a self-contained introduction to statistical mechanics.

In the first chapter the basic distribution laws of Maxwell–Boltzmann, Bose–Einstein and Fermi–Dirac statistics are derived through the device of assuming each energy-level to be highly degenerate so that Stirling's formula can be employed. The procedure is partially justified by a nice numerical discussion of the translational energy-levels of a particle in a box, and is certainly the most suitable for an introductory book of this kind. Subsequent chapters deal with applications: first to the specific heats of solids and gases and then to black-body radiation and the theory of metals. In keeping perhaps with the strictly physical emphasis of the book, there is no account of the Bose–Einstein phase-change.

Within its scope, the book is reasonably ambitious and well planned. The chapter on the specific heat of solids contains a useful introduction to Brillouin zone theory, which is, of course, taken up again in the final chapter on the electronic theory of metals. This last chapter deals not only with electronic specific heat and thermionic emission but also with transport phenomena and the Wiedemann–Franz law. It is, however, somewhat surprising in view of the emphasis on spectroscopic aspects of the earlier volumes that rather little is said about the intensities of spectral lines; and polyatomic molecules are dealt with only very summarily.

Detailed criticism is perhaps out of place in a review of this kind, though the use of H for an electric field is sufficiently extraordinary to deserve comment, and there are other instances of none too happy notation. More serious, in my judgment, is the lack of references to primary sources (which was true also of the previous volumes). This is particularly unfortunate since not infrequently, particularly in the later sections, formulæ are quoted which are not derived in the text.

Nevertheless the book, with its freshness and vigour, is a useful addition to the literature not only on quantal statistics but also on the electronic theory of metals. If, as is my opinion, it is more suitable for introducing a mathematician to theoretical physics than a physicist to theory (for the mathematics is somewhat uneven), that is not necessarily a serious defect.

The book ends with appendixes on the values of fundamental physical constants (derived from R. T. Birge's 1941 article) and a table of contents for all three volumes. G. S. Rushbrooke

ORGANIC CHEMISTRY FOR DEGREE STUDENTS

Textbook of Organic Chemistry

By Prof. Carl R. Noller. Pp. ix+643. (Philadelphia and London: W. B. Saunders Co., 1951.) 29*s*.

FOR nearly a century now the integrating theory behind the ever-increasing facts of organic chemistry has been the theory of gross structure, correlating the reactions and physical properties of organic molecules with the kinds of atoms present and with the order in which the atoms are bonded to each other in the molecule. This theory has been exceptionally fruitful and has led to the determination of the constitution of very complicated molecules and to the synthesis of hundreds of thousands of new compounds, many of which have important practical uses. Nevertheless, the development of the theory of the electronic structure of atoms and molecules has provided a more detailed picture of the nature of the forces holding atoms together, with the result that now it is often possible to give a consistent interpretation of the behaviour of organic molecules. Consequently, organic chemists are concerning themselves more and more with how organic reactions take place, that is, with the mechanism of reactions. It is these aspects of organic chemistry that Prof. C. R. Noller stresses in his new text-book. The introduction into basic text-books of organic chemistry of any consideration of reaction mechanisms has been very slow, and Prof. Noller is to be congratulated upon placing considerable emphasis on the explanation of physical properties and on the mechanism of organic reactions. It is most desirable that students graduating in chemistry and allied sciences should be acquainted with the current ideas and language of organic chemistry.

In the earlier chapters the student is introduced to the subject-matter gradually. No compound is used in the methods of preparation or in the reactions unless its structure has been discussed previously. For example, when alkanes and alkenes are first considered, no methods of synthesis are given. Instead, discussion of these procedures is delayed until the student is familiar with the methods of preparation and with the reactions of alcohols and alkyl halides. Reactions which are pedagogically bad, such as the halogenation of alkanes, are not presented until the student is able to see them in their proper perspective. Monofunctional aliphatic compounds are considered first, then monofunctional and polyfunctional aromatic compounds, and finally a return is made to polyfunctional aliphatic compounds. This progression permits the requirements of different students to be met by a single course. The text contains an amount of material that can be covered in ninety to one hundred lectures.

The layout is attractive, and the printing and production are excellent. The use of regular hexagons for benzenoid compounds is to be commended. Only one formula has been noted as in error—that of terylene (p. 416). The personalities of organic chemistry are portrayed in brief biographical footnotes that accompany the first mention of a "named reaction", etc. There is an appendix on the pronunciation (American style) of organic chemical words which is scarcely necessary if the text is to be used in conjunction with a lecture course.

A chapter devoted to organic peroxides, autoxidation and antioxidants is a commendable innovation, while the chapter on organometallic compounds contains an account of the newer developments in organosilicon chemistry. The chapter on stereoisomerism contains an admirable introduction to the topics of absolute and relative configuration. The description of the boat and chair conformations of *cyclo*hexane as *cis* and *trans* forms (p. 562) is deprecated. The *cis–trans* terminology was introduced to describe the isomerism, about an ethylenic bond and within a single plane, exemplified by maleic and fumaric acids. The subsequent extension of this terminology to describe the isomerism in three dimensions of di-substituted *cyclo*alkanes, etc., was unwarranted, but has become sanctioned by long usage. The further extension of this terminology to include the boat and chair conformations of *cyclo*hexane would confuse fundamentally different phenomena and would seriously weaken the value of established *cis–trans* usage. This is a criticism of a point of detail, however, and the book as a whole can be warmly recommended as a reasonably priced text-book of organic chemistry for students in British universities. S. H. HARPER

LABORATORY TECHNIQUES IN THE TESTING OF MILK

Milk Testing

The Laboratory Control of Milk. By Dr. J. G. Davis. Pp. 260. (London: Dairy Industries, Ltd., 1951.) 15*s*.

THIS book is described in the preface as a "practical manual for the bench worker", but many, including the reviewer, will no doubt also keep it as a ready form of reference on all dairy subjects where laboratory technique of a specialized nature is required. The manual is not merely a collection of methods, for Dr. J. G. Davis has given the reader the benefit of his many years of experience both as a practical chemist and bacteriologist, and also as a technical director of one of the largest dairy companies in Great Britain. The methods for the control of the quality of milk are therefore one of the book's main purposes. Many of the methods embodied in British Standards have been quoted *in toto*. Since these are the result of collaborative study by dairy chemists, public analysts and independent analysts, they can be accepted as authoritative. Dr. Davis can quote from personal knowledge of the many discussions and tests which preceded the formulation of these methods, since he is a member of long standing of the relevant committees of the British Standards Institution.

Dr. Davis has described a number of interesting personal observations which may be new to the reader; for example, the experience of a milk having a 'disgusting' odour which changed to that suggesting mushrooms in a few hours, and which finally vanished completely. It is to be hoped that the bench worker will profit from the many references in the text, for these are a mine of information for the willing searcher. How many, however, will realize the possibilities of Meihuizen's oven, or trouble to look up the reference when told on p. 103, "For a description of an oven designed for the determination of moisture see Meihuizen (1929)"? Several tobacco laboratories and my own laboratory have adopted this oven, which passes evenly a forced draft of air heated, and if necessary dried, at a predetermined temperature over all the samples in a cylindrical oven, provision being made for evacuating if required.

Prominence has been given to the freezing-point depression as the most reliable guide to the presence of added water. Dr. Davis has given a well-reasoned and unbiased review of the literature on the subject, rightly pointing out the empirical nature of the Hortvet test. In his remarks on the use of sugar solutions for testing the accuracy of the thermometer, I could have wished that the operator in possession of a thermometer calibrated by the National Physical Laboratory were also told that, with the aid of such an instrument as a standard of temperature, sugar solutions could even more usefully be used as a check on technique. The false view is currently held in some quarters that the freezing-point depression of milk is measured in 'Hortvet' degrees. On the contrary Hortvet used, as his standard, thermometers calibrated by the U.S. Bureau of Standards on the International Temperature Scale. When an empirical test relies on accurate standardization of apparatus, technique, etc., and cannot be checked by any absolute method, it is of fundamental importance that the one factor which can be standardized independently, namely, the thermometer, should have the benefit of this standardization.

As might be expected from a bacteriologist of Dr. Davis's standing, particular attention has been devoted to modern bacteriological testing of milk. His summary of comparisons of various bacteriological tests in the form of table on p. 119 is the outcome of many years of careful observation. The resazurin test, of which Dr. Davis has made a special study, is described with a wealth of practical detail, and with many hints on the correct interpretation of results. An unusual feature of such a book is a chapter on the organization and equipment of a dairy control laboratory, and the author has obviously given careful thought to the suitable design of such laboratories. Many of his ideas could, in fact, usefully be employed in any modern analytical laboratory.

For a book so packed with data, the errors are comparatively few, and fortunately these will not worry the bench worker. On p. 31, fat is described as having a specific gravity of 0·93 per cent. While sodium thiosulphate is employed to break up any mercury-amino body in Kjeldahl determinations, it is scarcely necessary to use it with a copper–selenium catalyst (p. 59). The inexperienced laboratory worker might be confused by the wording in the directions for preparation of standard solutions, as in some cases this suggests that the reagent is added to a volume of water and not dissolved and the solution bulked to the volume (pp. 230, 231).

The book is profusely illustrated and contains such a mass of useful data that it will surely find an indispensable place in the library of all dairy laboratories and form a most ready guide to all analysts who have to test milk and its products.

J. KING

Encyclopedia on Cathode-Ray Oscilloscopes and their Uses

By John F. Rider and Seymour D. Uslan. Pp. vii+982. (New York: John F. Rider Publisher, Inc.; London: Chapman and Hall, Ltd., 1950.) 75*s*. net.

THIS impressive volume, in common with most Rider publications, is not an advanced text-book. It has been compiled for those users of oscilloscopes—students, teachers and others—who have had a limited training in electronics and who can profit by obtaining a thorough understanding of the principles involved in the design and application of an instrument that is nowadays one of the most important items of apparatus in the lecture room, laboratory and factory.

The first half of the book contains a thorough account of the construction of the cathode-ray tube and the design of the associated circuits, as employed in American commercial equipment. The British reader may find the continual reference to American types of cathode-ray tubes and valves rather disconcerting; but this is more than compensated for by the clarity of the exposition. The more advanced reader will notice that there is no reference in the chapter on time bases to the Miller type of circuit that is frequently used in British oscilloscopes, and that a description of the wide-band chain amplifier has been omitted. No doubt these omissions will be corrected in the next edition.

The second section of the book covers the main applications of the oscilloscope to the testing of radio receivers and transmitters and to the measurements commonly made in the laboratory and factory. These chapters are well illustrated with oscillograms showing the wave-forms due to typical faults in the circuits under test.

There is a long chapter illustrating the wave-forms of oscillations containing harmonics up to the sixth, and this should enable the reader to identify the various wave-forms he may encounter in his experimental work. The book concludes with a chapter giving the circuits and a brief explanation of each of some seventy commercial oscilloscopes of American manufacture.

Although a book covering such a vast subject as oscillography cannot contain details of every aspect, the authors have produced a volume that will prove to be of great value to those for whom it has been compiled. G. E. Ashwell

Vorlesungen über Theoretische Physik

Band 4: Optik. Von Prof. Arnold Sommerfeld. Pp. xvi+390. (Wiesbaden: Dieterich'sche Verlagsbuchhandlung Inh. W. Klemm, G.m.b.H., 1950.) DM. 18.50.

THIS volume on optics follows the other parts of Sommerfeld's lectures on theoretical physics in its mathematical elegance and clarity, while never allowing the reader to forget the connexion of the mathematical problems with physical reality. The material is deliberately arranged in a somewhat unorthodox sequence. The theory of plane waves and plane interfaces (including refraction, reflexion and interferometers) is followed by relativistic theory and the optics of moving media. Dispersion theory is treated using the results of wave mechanics of the atom, and the section dealing with phase, signal and group velocity is of very convincing simplicity and completeness. Crystal optics is covered fairly briefly, but two full chapters deal with diffraction, one of the subjects to which Sommerfeld made decisive contributions. There is a short list of problems, mostly to derive generalizations of results mentioned in the text, and instructive notes on their solution.

In the review of earlier volumes (see *Nature*, 168, 887; 1951) I remarked on the desirability of having the series completed and of making a translation into English. Several correspondents have since informed me that the last volume is in course of publication, and that a translation is being prepared.

R. E. Peierls

The Apple and the Spectroscope

Being Lectures on Poetry designed (in the main) for Science Students. By T. R. Henn. Pp. xix+166. (London: Methuen and Co., Ltd., 1951.) 12*s*. 6*d*. net.

THOSE who devote their lives to the pursuit of natural science often realize how little they know of English prose and poetry, which contribute so much to the thought of people educated in the humanities. A few years ago, a group of young Cambridge scientists asked for instruction during the 'long vacation' in English literature and language. The series of lectures that was arranged proved very popular, and the lectures given by Mr. T. R. Henn as part of this course have now been published. The first eight chapters are about poetry, and an appendix contains the poems and passages examined in the text. Two chapters are entitled "Notes on a Background to English Literary History", with an appendix of authors and their dates. The concluding chapter, full of interesting reflexions and suggestions about reading, is accompanied by a list of works suggested for casual reading.

This delightful little book can be recommended to those who wish to know something of the qualities which distinguish good poetry and prose. It is full of interest in its matter and approach, while its consideration of the significance of words may prove of practical value to those who write scientific papers and lecture notes. There are some pleasing illustrations, and it is easy to see why the author's lectures to Cambridge scientists were so popular.

H. H. T.

The Bird Lover's Week-End Book

By Eric Hardy. (Week-End Library.) Pp. 444. (London: Seeley, Service and Co., Ltd., n.d.) 15*s*. net.

THIS "Week-End Book" is an ambitious volume, its author trying to cover a very big field. The first chapter on the bird-watcher's year is a lengthy review of the passing months as seen by the author and recorded in weekly notes. He then gives a key to bird identification under such headings as "What the bird looks like", "the bill", "upper parts" and so on. It will be gathered that the book is written for the amateur ornithologist, and the beginner at that. There is no doubt that the tyro will find it a real help.

The chapter on the bird-watcher's equipment contains much useful information on subjects varying from binoculars to bird-baths. Reference to subjects is here facilitated by their alphabetic arrangement. Bird haunts and bird holidays are among the topics dealt with, and there is a long chapter on "nicknames" of British birds. The reader wanders on through chapters on migration, British birds abroad, etc., and winds up with a glossary of the bird-watcher's terms. There is no doubt that the amateur ornithologist spending a week-end in the countryside will find this a helpful book. Frances Pitt

PROPERTIES OF VITREOUS WATER

By Dr. J. A. PRYDE and Dr. G. O. JONES
Department of Physics, Queen Mary College, University of London

THERE are a number of analogies[1] between the structure of water and that of vitreous or liquid silica, and many suggestions exist in the literature to the effect that water (like silica) can exist in the glassy or vitreous state. Vitreous pure water has not previously been obtained in bulk (though aqueous solutions can often be supercooled into glasses), but very thin films of water in an apparently amorphous non-crystalline state well below 0° C. have been obtained in various ways—for example, by very rapid cooling in liquid air[2,3], or by deposition from the vapour on a surface cooled below about −100° C. Burton and Oliver[4] showed that films formed by the latter method gave X-ray diffraction patterns typical of liquids and glasses. However, on heating, crystallization—or 'devitrification'—occurred, being complete at −80° C. As reported by Brewer, Cwilong and Dobson[5,6], deposition of very thin layers of this 'vitreous ice' on the cooled thimbles of hygrometers is a common and unwanted occurrence in meteorological experiments when the thimbles are below about −100° C.

The intention in the present work was to attempt to prepare sufficient vitreous water to allow some of its properties to be determined, especially its 'glass transformation temperature' T_g[7,8]. As shown in Fig. 1 (after Simon[8]), substances which form glasses show large discontinuities in first-order derivative properties such as the specific heat over a narrow range of temperature located by T_g. Below T_g the substance is conventionally called a glass, is not in internal equilibrium, and its first-order derivative properties are nearly identical with those of the crystal. Above T_g it is a (metastable) supercooled liquid, and its properties are continuous with those of the normal liquid above the freezing point. Of course, both as supercooled liquid and glass the substance is unstable relative to the crystal, and crystallization may occur at any temperature. For substances which form glasses, this is usually very slow except over a certain temperature-range, and if T_g is well below this temperature-range, as it is for most inorganic oxide glasses for example, it is possible to carry out real property/temperature measurements on the (metastable) equilibrium liquid over wide ranges of temperature well below the freezing point. (Sometimes, as with glycerol, devitrification is so slow at all temperatures that these measurements can be extended continuously down through the freezing point as far as T_g.) The many anomalous properties of water make such measurements especially desirable.

We must emphasize that in our experiments on water, carried out well below −100° C., the temperature was always below that at which the rate of nucleation is a maximum for this substance. Here, high viscosity is the barrier to crystallization, and the onset of crystallization sets an upper limit of temperature above which the experiments cannot be extended. In the experiments of other workers on the properties of supercooled water in bulk between the freezing point and about −20° C.[10], or on condensation in cloud chambers down to about −40° C.[11], maintenance of the liquid state depends essentially on the absence of nuclei, and the onset of crystallization sets a lower limit of temperature upon the measurements. The properties of the liquid between about −100° and −40° C. seem to be almost inaccessible to experiment, although droplets of liquid 'dew' can be formed from the vapour within this range on certain types of clean surface and persist for a short time[6].

Experimental Methods and Results

In the first experiments, carried out by one of us (G. O. J.) at the Clarendon Laboratory, Oxford, in collaboration with Prof. F. E. Simon, attempts were made to produce quantities of the order of one gram of vitreous water by rapidly cooling in liquid oxygen a block of porous copper containing water held in a fairly fine state of sub-division (of the order of a few microns). (It was hoped that a substantial proportion of the pores might be free of freezing nuclei so that crystallization could not spread throughout the liquid.) The block and its contents could afterwards be quickly transferred to a vacuum chamber for controlled heating. On the first occasion, the heating curve showed a quite sharp decrease in slope, corresponding to a sudden increase in heat capacity, at -147 ± 2° C. As soon as this was obvious, the block was re-cooled to liquid-oxygen temperature and a new heating curve taken, again with the same result. We believe that these were real observations of the characteristic behaviour of the glass transformation, but cannot attach much importance to the actual estimate of T_g because of the rather fine state of sub-division of the water and the possibility that it contained impurities such as the products of reaction with copper.

Unfortunately, these observations could not be repeated. In all later attempts the water formed ordinary ice in the pores—as could be confirmed by observing the 'flat' in the heating curve at 0° C. It was suspected that the copper must now be 'seeded' by some particularly effective type of nucleus for crystallization, so new samples were used. A 'book'

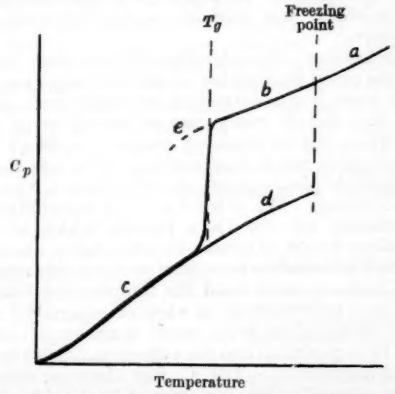

Fig. 1. Specific heat–temperature curves for a substance in the following forms (after Simon) : (*a*) liquid, (*b*) supercooled liquid, (*c*) glass, (*d*) crystal, and (*e*) start of equilibrium (metastable) curve for supercooled liquid

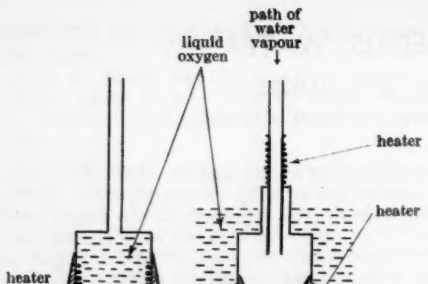

Fig. 2. Calorimeters used for measurement of thermal properties of vitreous water, showing method of deposition from water vapour

of nickel foil holding about a gram of water between its leaves was also tried, and many other variations introduced in the procedure (such as the use of stagnant liquid oxygen or nitrogen below their boiling points for more rapid cooling, and the application of strong heating in vacuum to attempt to destroy 'seeds' in the pores) without any further success.

In all subsequent experiments the method of deposition from the vapour was employed. The water was always double-distilled and freshly boiled before use. Fig. 2 shows two types of calorimeter used, and indicates how the temperature was maintained at that of liquid oxygen during deposition. The liquid oxygen could then be removed and the space surrounding the calorimeter evacuated for controlled heating. The advantage of type (*a*) was that the layer of water-substance, being on the outside, could be seen (it was noted that films prepared in this way were transparent at small thicknesses but imperfectly so at greater thicknesses). Type (*b*) was, however, more suitable for quantitative measurements because it enabled a known quantity of water to be deposited, and to be retained throughout the experiment; for greater accuracy in measurement, a radiation shield was used in conjunction with this calorimeter.

No behaviour characteristic of the glass transformation could be detected in any of a large number of such runs (some extending upwards from about −210° C.); but in every case an evolution of heat began when the calorimeter reached −129±1° C., causing a rapid rise in temperature. This was clearly an irreversible phenomenon, since it was not repeated after re-cooling. We attribute it to crystallization into ordinary ice (ice I)—a process which at this temperature would, of course, be irreversible—because no further irreversible evolution or reversible absorption of heat occurred until the temperature reached 0° C. This is of interest in view of reports[12,13] that another form of ice (with cubic symmetry) can be formed by deposition from the vapour on cold surfaces.

Crystallization at −129° C. was observed twenty-nine times in all. The quantity of heat evolved per unit mass of water varied from run to run between about 2 and 7 cal./gm., smaller values being observed with thicker layers. The specific heat of the water-substance below and above the temperature of the irreversible crystallization was found to be the same, within the possible errors of measurement (a few per cent), and agreed to the same degree of accuracy with known values for crystalline ice at the same temperatures.

As a control, the whole experiment was performed twice with pure ethyl alcohol, which is known to form a glass for which T_g is −178° C.[14]. It was found that a glass was obviously formed by deposition from the vapour at the boiling point of liquid oxygen, and the measured values of T_g, and of c_p below and above T_g agreed well with the published values (this is of interest because a glass deposited from the vapour at a given temperature might be expected to differ from one formed by supercooling the liquid to the same temperature). Crystallization occurred at −150° C. (the normal freezing point is −117° C.) with the evolution of a much greater quantity of heat than observed by us with water.

Discussion of Results

Crystallization. The remarkable constancy of temperature at which crystallization occurred might at first suggest the existence of a real transition point at this temperature. In fact, the change was found to be irreversible; indeed, a reversible transition from a low-temperature to a high-temperature modification cannot be accompanied by an evolution of heat. (The existence of characteristic temperatures for irreversible crystallization in particular circumstances has frequently been reported[5,6,10,11,13], but has apparently not been observed at temperatures below that at which the rate of nucleation is a maximum. It is normally thought to be due only to the fact that rates of crystallization varying very rapidly with temperature may cross the 'time-scale' of observation over a very narrow temperature range.) The actual temperature (−129° C.) is somewhat lower than the values (−90° to −80° C.) usually reported for the temperature at which crystalline ice appears during the heating of layers of 'vitreous ice' on the thimbles of dew-point hygrometers as used for observations on very dry air. However, as pointed out to us by Dr. A. W. Brewer, of the Clarendon Laboratory, Oxford, these layers are usually only of the order of molecular thickness and the ice cannot be seen until it has collected (by migration over the surface) into much thicker localized aggregates; it is not surprising that a higher temperature is required for an effective rate of migration.

The estimates of the latent heat of freezing at −129° C. varied from one run to another, as we have seen, being of the order 2–7 cal./gm. Before we can judge whether these are reasonable values, we have to know something of the form of the specific heat/temperature curve for liquid water below 0° C.—a difficult extrapolation since the specific heat has a minimum at about 35° C. and is still increasing with falling temperature at 0° C. Making use of Simon's suggestion[9] that the curve of specific heat against temperature for the equilibrium (metastable) liquid should be drawn to the origin in such a way that the entropy at absolute zero becomes the same as that of the crystal (see Fig. 1), we have a means of 'normalizing' the hypothetical curve. It is reasonable to assume also that the specific heat of the liquid does not fall below that of the crystal. Drawing the two extreme curves which, while meeting these conditions, give the largest possible difference between

the two estimates that they provide of the latent heat at −129° C., we arrive at values of about 20 and 40 cal./gm. If the liquid is, in fact, not in its metastable equilibrium state but is a glass at this temperature, the latent heat of freezing would be increased. We are forced to conclude, therefore, that the samples of water in our experiments were only partly vitreous, being, in fact, like badly devitrified pieces of glass (this was indeed their appearance). This conclusion follows rather obviously also from the fact that the amount of heat evolved per gram varied from one run to another, being much smaller than that observed for alcohol, and apparently depending on the thickness. It is known that the result of deposition from the vapour is very sensitive to the condition of the surface, and it would be expected to depend also on the speed of deposition. The 'latent heat of sublimation' to be dissipated is very large, and with a growing film of glassy substance of very low thermal conductivity the danger of local crystallization at 'hot spots' would increase. Better results might be expected if it were possible to deposit layers over very much longer times than those (of the order of hours) employed by us.

Glass Transformation. If we were to accept the results of the present specific heat measurements at their face value, we should conclude that T_g was not below the temperature at which crystallization sets in (since c_p for the deposited layer is the same as that of the crystal and shows no discontinuity) and was therefore impossible to locate exactly. It can scarcely be much above this temperature, and the two temperatures must therefore be quite close to each other, since a certain amount of mobility is possible at T_g—the temperature at which the adjustments necessary to reach configurational equilibrium can occur rapidly. Indeed in silica—structurally the closest copy of water—it is very difficult to conduct experiments in the transformation region because of devitrification. There is an element of doubt in our conclusion because it seems clear that only a fraction (say, between one-twentieth and one-third) of the material in our samples was actually vitreous, and it is by no means certain that the discontinuity in specific heat of the vitreous part could have been detected.

Fortunately we have a confirmatory estimate from the work of Kobeko, Kuwshinsky and Shishkin[16]. They pointed out that water as an impurity raised the value of T_g of ethyl alcohol (−178° C.) but lowered it in the case of glycerol (−88° C.). The value of T_g for water itself would therefore probably lie between these two temperatures. Moreover, T_g for pure hydrogen sulphate was the same as for a mixture of this substance with water of composition $H_2SO_4.2H_2O$. They therefore proposed this value, −127° C., as T_g for water. Kobeko had previously shown[17] by several examples that when mixtures of two substances in any proportions could be obtained

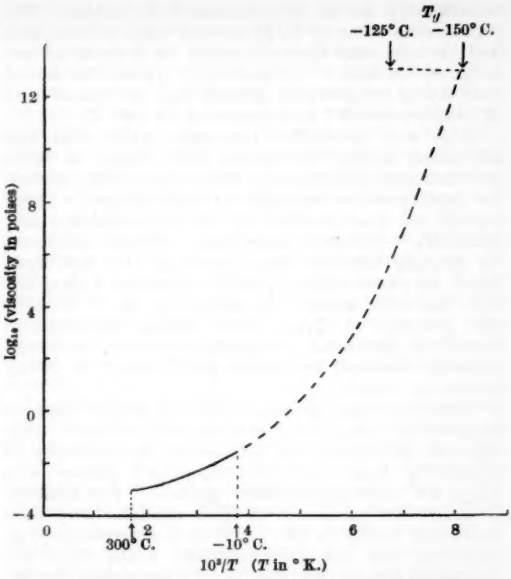

Fig. 3. Viscosity–temperature curve for water, extrapolated to T_g

as glasses, the value of T_g for the mixture varied smoothly and monotonically with composition, and we do not find any difficulty in accepting this estimate as being at least nearly correct. (There is no direct relation between the phenomena of glass transformation and crystallization, and no reason to doubt the reality of T_g for a substance because it cannot easily be obtained as a glass.) Our own estimate (−147° C.) from the first experiments with porous copper is lower, as would be expected if the water contained impurities, in themselves not glass-formers. It seems reasonable to assume that T_g for water lies at any rate in the range −150° to −125° C.

Structure of Water and Mechanism of Viscous Flow. The above estimate of T_g leads to certain conclusions of interest. It is a quite general observation[9,18] for all glasses that the viscosity at T_g is of the order 10^{13} poises. This enables us to locate another part of the viscosity/temperature curve for water, as shown in Fig. 3, where $\log_{10}$ viscosity is plotted against reciprocal absolute temperature. The short full line represents values obtained[19] in the range −10° to 300° C., and the broken line is an extrapolation drawn to meet the value corresponding to 10^{13} poises at T_g = −150° C. The slope of this curve is usually regarded as an 'activation energy', and it will be seen that its value, which increases from about 1·5 to 5 kcal./gm. mol. over the temperature-range covered by the experiments, must continue to increase very

Substance	Freezing point (° C.)	T_g (° C.)	$L_{vap.}$ at boiling point (kcal./gm. mol.)	$E_{visc.}$ at freezing point (kcal./gm. mol.)	$E_{visc.}$ at T_g (kcal./gm. mol.)	Source of estimate of $E_{visc.}$
Water	0	−150 to −125	9·7	5·1	>16	Present work
n-Propyl alcohol	−127	−172	9·8	9·7	20	Graphical estimate from published results[24]
iso-Butyl alcohol	−108	−155	10·3	11·2	22	,, ,,
Glycerol	17	−88	18*	12·7	29	,, ,,
Glucose	146	30	—	19	125	Recent unpublished results[25]. See also ref. 26.
Silica	1,713	1,200	—	—	175	See ref. 22

* Estimated from vapour-pressure data

considerably as the temperature falls further. We estimate its value at T_g as greater than 16 kcal./gm. mol. (a minimum figure obtained by a linear extrapolation between 0° C. and T_g); it will be noted that this is considerably greater than the latent heat of evaporation (9·7 kcal./gm. mol. at 100° C.).

It is well known[20–22] (see also table) that the activation energy for viscous flow, $E_{visc.}$, is large and increases continuously with falling temperature for liquids which are able to form glasses. These liquids are characterized by low co-ordination and markedly 'structural' nature and owe their coherence to strongly directed bonds such as the 'hydrogen bond' (in water, alcohols, etc.) or the ionic-homopolar Si-O bond (in silica). As shown by A. G. Ward[20], the increase of $E_{visc.}$ with falling temperature implies an increase in structural character—a change actually observed by Bernal and Fowler[23] in X-ray studies on water.

Values of $E_{visc.}$ greater than the latent heat of evaporation ($L_{vap.}$) do not appear to have been reported previously, on account of the difficulty of measuring $E_{visc.}$ for low-temperature glasses and $L_{vap.}$ for high-temperature glasses. Fortunately, however, the viscosities of three alcohols have been measured nearly to T_g[24], and in the accompanying table we list our own estimate, made from the published graphs, for $E_{visc.}$ at T_g for these liquids, together with values of $L_{vap.}$ and some other data of interest.

It will be seen that in *n*-propyl alcohol, *iso*-butyl alcohol and glycerol, as in water, $E_{visc.}$ can greatly exceed $L_{vap.}$ at low temperatures (the variation in $L_{vap.}$ with temperature is relatively small and does not affect the argument). This supports the suggestion of various authors[20,21,27,28] that the flow process in these liquids involves the breaking of strongly directed bonds rather than the movement of molecules. (In 'normal' liquids such as the metals, 'rare gases', non-polar organic substances and ionic salts, $E_{visc.}$ is always much smaller than $L_{vap.}$—usually about 1/3–1/4 of its value, or 1/8–1/25 in metals.) In the case of silica, $E_{visc.}$ at T_g is about twice the energy of the only type of bond present, the Si-O bond (~90 kcal./gm. mol.), and for water and these alcohols it is 3–4 times greater than the strength of the hydrogen bond from hydroxyl groups (6–8 kcal./gm. mol.) which is assumed to be responsible for their cohesion[29–31]. In glucose, which has a complicated molecule containing five hydroxyl groups, the value of $E_{visc.}$ is remarkably high.

Conclusion and Summary

In spite of the great difficulty of producing completely vitreous pure water, there is evidence that under favourable conditions water forms a glass, with the transformation temperature T_g lying between −150° and −125° C. The main implication of this conclusion is that the increase in structural character of water with falling temperature, already detectable above 0° C., must continue to a very marked extent as the temperature is lowered still further. As in other liquids containing directed bonds, the value of activation energy for viscous flow can exceed the heat of evaporation and the strength of a single bond by a large factor.

An unexpected result is that specimens of glassy water containing varying proportions of crystalline ice complete their crystallization (apparently into ice I) precipitately when the temperature is raised to −120° C.

We acknowledge the interest and collaboration of Prof. F. E. Simón, of the Clarendon Laboratory, Oxford, in the early stages of this work, and later the help and facilities given us by Prof. H. R. Robinson, at Queen Mary College, London, and the careful work of Mr. W. A. G. Baldock in making the calorimeters used in the experiments. We are indebted to the Central Research Fund of the University of London for the loan of apparatus, and to Imperial Chemical Industries, Ltd., for a grant-in-aid.

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FACTORS INFLUENCING CHANGE IN HUMAN BEHAVIOUR

A FULL morning's session at the recent Belfast meeting of the British Association was devoted to the problems of "Resistance to Change", more especially resistance to the application of well-founded scientific knowledge in industry and agriculture. In the first half of the morning some of the more general questions were discussed by Section J (Psychology); in the second part of the proceedings, this Section joined with Section M (Agriculture) in a symposium on resistance to change in farming. Most of the speakers were more particularly concerned with the problems encountered by research, educational and advisory services.

Opening the general subject, Prof. C. A. Mace (Birkbeck College, London) developed the thesis that much of what is called 'resistance to change' is, in fact, failure in the process of communication. The sources of failure are not entirely at the receiving end; some are in the process of transmission. Quoting Prof. Georges Friedmann's observation that "there has been no technological revolution in most

of the professions", Prof. Mace went on to explore the prospects of such a revolution in the educational and advisory services. This revolution is coming, he said, through the use, not of precision machines, but of precision techniques. He cited the B.B.C. "Audience Research", a recent report on "Foremanship Training" by A. J. Flook, and a study of "Human Relations Training" by P. Castle, of the National Institute of Industrial Psychology. The essential features of these new techniques of 'precision education' are threefold: the communication, instead of being diffused, is directed to a selected target audience; it is adapted in content and form to actual needs empirically ascertained; and by suitable 'feedback' devices the impact of the communication is accurately assessed. As the word 'broadcasting' has come to be almost a synonym for 'mass communication', broadcasting the thing is "becoming a technique for focusing a beam of specific intelligence upon a particular public with particular ends in view". The importance of these developments lies in the generality of the principles involved. These principles apply to every form of communication from the poster as simple as "Mind how you go" to the whole curriculum of studies for a B.Sc. degree. They apply to every form of advisory service. Advisory services are essentially concerned with combating resistance to change; but sometimes they themselves are resistant to suggestions for change in the methods they employ. They themselves need to be serviced by advisory research in their problems of communication.

Passing reference was made in the opening paper to certain critical phases in the life of an individual at which variations occur in his "coefficient of resistance to change", and one of these phases was the subject of the second paper, in which Miss M. Woodward (Bedford College, London) reported evidence of "changes in social participation following the birth of a child". In the respects considered, this is a more important event than that of marriage. A survey was made of the membership of societies, the informal relations with friends and working associates, and the leisure pursuits and the interests of 186 women attending a clinic in a dormitory area of London. Impressive facts were adduced regarding the general decrease in a mother's social activity outside the immediate family circle after childbirth. The consequent sense of isolation and increased dependence on the husband for the satisfaction of social needs may, it was suggested, place a serious strain upon marital relations. The findings in this survey acquired additional significance in the context of the symposium. Later speakers were to stress the importance for the diffusion of change of social participation in the life of a group larger than the immediate family circle, and Miss Woodward's observations may contribute to the explanation of the characteristically conservative influence of family life as such.

In the second half of the morning's session, Mr. J. M. Mogey (director of the Oxford Pilot Social Survey) introduced the discussion of resistance to change in agriculture by a historical and anthropological analysis of factors affecting rate of change in the agriculture of Northern Ireland. Owing to physical and historical conditions, Northern Ireland is a country of small-scale farming, and one in which the basic social unit is the farming family. These units have in part been informally organized in clusters of from ten to twelve farms co-operating on the basis of ties of kinship and proximity. New ideas and techniques filtered through to the ordinary farmer only in so far as they fell within the economic potential of the single small farm. In the face of resistance arising from a tradition of informal co-operation, government action in wage control and the promotion of marketing schemes has had only a limited effect. The resistance to official action has been greatest in respect of agricultural education. There has been a failure to work through the informal groups of the countryside. The conclusion was drawn that in a community of small owner-occupiers improvements in farm techniques must be demonstrated by equals. A raising of the level of skill can be expected only through local experiments on the basis of a complete farm. A few successful farms assisted by an advisory service scattered over the countryside and open to visits from neighbours, with the farmer himself explaining the methods employed, would arouse interest and create a desire for more instruction.

Prof. R. Rae (director of the National Agricultural Advisory Services) followed with a discussion of the farmer's attitude to technical advances. He placed high among the factors that influence the farmer's attitude the prospect of reasonable profit from the business of farming. The success of an advisory service depends on the general standard of education of the farmers, and on the introduction of agricultural science to young men in the formative period of their lives. He, too, stressed the importance of demonstrating new methods on farms open to visits from neighbours. He thought that there is no section of the community more receptive to new ideas than the top-grade farmer. In the lowest grade little can be done. In this group there are too many who suffer from the combination of two disabilities—old age and lack of experience. It is the middle group, the majority, that offers the greatest promise to the advisory services. Farming is essentially a complicated business, and the farmer must be a business man able to organize labour, and so something of a psychologist. In addition, he must be something of an engineer and an economist and must also be a craftsman; and it is an advantage for him to have some understanding of agricultural science. It is this complexity of requirements which constitutes the reason for the existence of advisory services.

The session concluded with a paper by Dr. Roland Harper (University of Leeds) on psychological aspects of the application of new knowledge and techniques in agriculture. Dr. Harper was concerned with the problems arising in passing scientific knowledge "down the line" from the research laboratory to the farm. The expression brought out the close analogy between the problems of an advisory service and those of the management consultant in promoting communication from higher management to the worker at the bench. It is mainly the psychological factors, Dr. Harper suggested, which prevent the established results of agricultural research from being applied with expedition. He proceeded to review some of the more relevant psychological studies—Lewin's investigation of factors influencing food habits, Ryan and Gross's study of the diffusion of seed corn in Iowa, and Wilkening's "socio-psychological approach to the study of the acceptance of innovations in farming". Expanding the survey, Dr. Harper elucidated some of the general psychological concepts relevant to the problem—motivation and attitudes, social participation and the cognitive aspects of communication. He concluded with some practical suggestions. His

analysis reinforced the arguments of previous speakers for operating through informal groups. Much more, he thought, could be done through the guided discussion group. Special emphasis should be placed on means for assessing the success or failure of the methods used by advisory services. He advocated co-operative research in Great Britain similar to that which he had cited from the United States. He suggested that greater attention should be paid to the attitudes of farmers towards new procedures, and very special attention given to their "uninhibited reactions to our present advisory services".

Contributions to the discussion from the floor were, very appropriately, in the form of such uninhibited reactions of the practical farmers themselves. They reinforced what Dr. Harper and others had said regarding the importance of understanding the needs of those for whom advisory services are provided. It seemed clearly to emerge that scientific advice administered neat is apt to be ineffective. The scientific advisory officer needs to be not only a man of science but also something of a management consultant, competent to advise the farmer in costing the procedures suggested, and able to assist him in adapting general principles to the special circumstances and the particular economy of his farm. This conclusion was in close accordance with an opinion expressed in a conference on farm management organized by the British Institute of Management earlier in the year. A combined scientific and management advisory service is what is most needed. Such a service is of especial importance for the small farmers who comprise the vast majority of those for whom these services are provided.

There would appear, too, to be a substantial body of opinion which favours more detailed and intensive advisory services to a smaller number of farms in preference to a wider service spread more thinly. If it is indeed true that farmers learn more readily from practical demonstrations of successful farming than from the spoken or written word, a well-distributed selection of farms serviced in detail might be more effective than more diffused methods. It is agreed, however, that, whether focused or diffused, advice must be followed up by inquiries whether the advice has been acted on : If not, why not ; and if so, with what effect ? Follow-up provides the 'knowledge of results', the 'feed back', upon which success depends ; and to make this a routine procedure may be more useful and less expensive than the organization of special attitude and opinion surveys of consumers' needs and reactions.

It is of interest to note that, although the symposium was especially concerned with advisory services to the farmer, the policies and principles discussed were of universal application. Regulations continue to multiply, but in all modern civilized societies there is a greater proportionate increase in the use of methods based on advice and persuasion. Advisory services are developing for agriculture, for building and most of the manufacturing industries, and the ordinary citizen has an immense variety of advisory services concerned with his health, his education, his vocational needs, his civil rights and responsibilities. In all these advisory services there is a need for better understanding of the sources of friction and resistance in the channels of communication from the laboratory or the field station to those who have to turn the results of scientific research to practical account.

This was the first joint meeting of the Agriculture and Psychology Sections in the history of the British Association ; but with the continued expansion of research and advisory services, it may well be the precursor of many symposia on the psychological aspects of the technique of applying the methods and results of science to human affairs.

BIOLOGICALLY SIGNIFICANT MACROMOLECULES

A MEETING of Section B (Chemistry) of the British Association took place in Belfast on September 9 before a packed audience under the chairmanship of Prof. M. Stacey (professor of organic and biological chemistry in the University of Birmingham), the subject being "Biologically Significant Macromolecules".

Prof. Stacey spoke on "Polysaccharides of Medical Importance". In the normal functioning of the animal body the synthesis of macromolecules and their subsequent breakdown is of obvious importance. Continuous biological polymerization and depolymerization are essential in growth processes and provide a fascinating study especially in the polysaccharide field. It is perhaps not surprising that the medical applications of complex carbohydrates are becoming of increasing importance.

A good deal is now known regarding the so-called immunologically specific bacterial polysaccharides, especially in the Salmonella and Pneumococcus groups. In the pneumococcus the polysaccharides occur mainly on the surface of the bacterial cell as a capsule from which they may pass into solution in the growth medium of the organism. When they penetrate into the animal body, they stimulate the production of immune proteins, and *in vitro* in very high dilution they give rise to a specific precipitate on reaction with homologous immune serum. There are more than fifty of these specific polysaccharides, each possessing a different chemical structure, though their physical properties may be similar. A special characteristic is that many of them possess hexosamines and hexuronic acids, in addition to hexoses, as constituent building-units. During recent years, Prof. M. Heidelberger and his colleagues in the United States have shown that the pneumococcus polysaccharides free from protein will immunize human beings against infection, and a mixture of polysaccharides may be used as a prophylactic vaccine against pneumonia. The protection will last up to twelve months, and in large communities the incidence of many types of pneumonia can be lessened.

Vaccines against typhoid, dysentery and cholera, etc., mainly owe their immunizing properties to the presence of a complex carbohydrate residue which contains glucosamine and galactose and which is conjugated to phospholipids and amino-acids.

Seven distinct polysaccharides have been obtained from the mycobacterium which causes tuberculosis in humans, and their specific serological reactions are being studied. When freed from protein, they do not appear to give rise to any immunity. When polysaccharides having molecular weights of the order of a million are degraded by acid or by enzymes, they can often be injected into animals without setting up any immunity in the host. They may,

however, cause skin reactions in sensitive individuals, and some forms of allergy can be traced to distinct chemical structures or even groupings, though protein constituents or nucleoproteins are more likely to be incriminated in such cases.

The bacterial polysaccharide dextran has been degraded by a variety of means, and a fraction having a molecular weight not greater than a hundred thousand has been used successfully as a blood plasma substitute. It is being used extensively, particularly in Britain and Sweden, in conjunction with natural plasma against shock, burns and loss of blood. The polysaccharide is composed entirely of glucose units, and it is completely metabolized in the body within a few days.

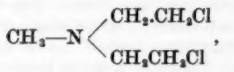
Another valuable dextran product is the sulphate made from a fraction having a molecular weight of about twenty thousand. This is essentially non-toxic, and it prevents the coagulation of blood and is likely to become valuable in post-operative work and in thrombosis. It has an action like heparin, the natural anticoagulant. Blood-group substances present in the red cells and tissues of individuals of groups A, B or O, etc., are mainly of a polysaccharide nature. Their study by chemical means will give valuable information on inheritance characters.

Body 'building' constituents, such as bone, cartilage, tendons and joint fluids, are polysaccharides containing hexuronic acids, amino-sugars, sulphate and acetyl residues. They can be depolymerized by enzymes such as hyaluronidase, lysozyme, etc., and the state of polymerization appears to be important in certain rheumatic conditions. The enzymes may be under the control of cortisone or the adrenocorticotropic hormone, and it is of great importance to make structural studies in the group.

The biosynthesis of one macromolecule may depress that of another type in its immediate vicinity. There is some evidence that certain bacterial polysaccharides will suppress the formation of the nucleoproteins in some tumours, and efforts have been made for some years by Dr. M. J. Shear and his colleagues in the United States to apply this in the attempted cure of some forms of cancer. In a somewhat similar way microbial and other polysaccharides may cause the slowing-down or may suppress the growth of viruses such as the influenza virus. Physical factors come into play, and efforts are being made to investigate virus multiplication and inhibition along these lines.

Dr. B. E. Conway (Chester Beatty Institute, London) then gave an account of the "Physical Chemistry of Deoxyribonucleic Acid". The probable importance of deoxyribonucleic acid conjugated with basic proteins to form the chromosomal nucleoproteins and in the process of cell division was stressed, and the action of ionizing radiations and radiomimetic substances such as the 'nitrogen mustards' on dividing cells was briefly indicated. Attention was directed to the great amount of information to be gained by studying the effects of these agents on isolated deoxypentosenucleic acid. However, prior to investigations of this type it is necessary to have some information concerning the physical condition of nucleic acid solutions. Dr. Conway briefly reviewed experimental studies by various workers in which the ultracentrifugal, diffusion, viscosity, streaming birefringence and light scattering behaviours were observed. These experiments led to a picture of nucleic acid solutions as consisting of a dispersion of highly elongated, fairly rigid particles, between which there is considerable electrostatic and/or van der Waals' interaction. The marked effect of simple uni-univalent salts on the viscosity of the nucleic acid, together with the observation of Signer and Schwander that the orientation of the nucleic acid particles in streaming birefringence experiments is independent of sodium chloride concentration in the solution, emphasizes the apparent importance of electrostatic interactions between particles in nucleic acid and its solutions. In addition to these effects with simple salts, the addition of hydrogen-bond competing agents (or 'denaturing agents'), such as urea or phenol, to the nucleic acid solutions produces an irreversible effect in which it appears that the nucleic acid, although unchanged in molecular weight by these agents, becomes more compact by a loosening of intramolecular hydrogen bonds which appear to stiffen the extended rod-like structure.

Both radiomimetic agents, for example, the nitrogen mustard



and X-rays have an apparent depolymerizing effect on nucleic acid. However, the chemical effects of these two types of agents are very different, and only the physical changes of viscosity and molecular weight are similar. In the case of the nitrogen mustard, direct alkylation of the nucleic acid alters the molecule to a more compact form. At the same time and afterwards, further fission of the nucleic acid chain occurs giving fragments of lower molecular weight. The chemistry of these processes was briefly discussed. In the case of the action of X-rays on aqueous solutions of nucleic acid, the reactive agents are the hydroxyl, hydrogen and hydroxylonium free radicals, the latter being formed only in oxygenated solutions. The chemical action of hydroxyl radicals on nucleic acid and simpler analogues was described. There is a wide variety of reactions which can be brought about by these hydroxyl radicals interacting with nucleic acid. The effects of X-irradiation of nucleic acid in oxygen are of particular interest, for here degradation continues long after cessation of the irradiation. The importance of hydrogen peroxide formed during the irradiation under these conditions was discussed, and the possible relation of the increased radiosensitivity of organisms in the presence of oxygen was pointed out. Dr. Conway's talk was beautifully illustrated by slides showing stages of cell division.

In the final paper, Dr. G. A. Gilbert (University of Birmingham) spoke of the work in the Birmingham laboratories and elsewhere on "Enzymes for Building Natural and Synthetic Starch". He said that natural starch contains two distinct kinds of polymer—a long straight-chain polymer (two hundred units) termed 'amylose', and a highly ramified polymer termed 'amylopectin'. Amylose tends to come out of solution in hot water in the form of a granular powder (retrogradation), whereas amylopectin forms a thick gel. Tough fibres resembling cellulose can be made from amylose. It gives a blue-coloured complex with iodine, the molecules and ions of which may fit inside a helix-type of chain structure. Amylopectin gives a reddish colour with iodine, and the amylose content of a starch may be measured by the 'blue value' of the iodine complex measured spectrophotometrically. Separation of amylose from a starch paste may be

achieved by the addition of a variety of reagents, including thymol, paraffins, aluminium phosphate, etc.

Amylose may be synthesized by the action of an enzyme (Hanes's phosphorylase or *P*-enzyme) acting upon glucose-1-phosphate under appropriate conditions. The phosphorylase may be extracted readily from potato juice and obtained in a highly purified form. The synthesis using purified materials will not begin until a 'primer' consisting of several glucose units with the starch-type pattern is added. The synthesis starts from the non-reducing chain ends, and the glucose units are joined by 1 : 4 α-glycosidic linkages. Amylose may be converted into amylopectin by a second 'branching' enzyme termed *Q*-enzyme which has been obtained in Birmingham in a crystalline condition. The branching may involve 1 : 6-linkages which are now termed 'cross' linkages. The synthesis of the starch components by these enzymes, alone and in admixture in varying proportions, gives a valuable means of studying an important biological synthesis. The depolymerization of starch components can be studied by means of the 'amylase' enzymes, which have some commercial importance. There is a good deal of overlap in the mode of action of starch-synthesizing and -depolymerizing enzymes obtained from microbial, protozoal, plant and animal tissues.

The meeting concluded with a lively discussion.

OBITUARIES

Prof. C. B. Fawcett

Prof. C. B. Fawcett, who held the chair of geography at University College, London, for twenty-one years until his retirement in 1949, died on September 21 at the age of sixty-nine.

A graduate of University College, Nottingham, he later studied under Herbertson at Oxford before becoming lecturer in geography at University College, Southampton, in 1914. He moved in 1919 to the University of Leeds, where he was in charge of the young Department of Geography until he was appointed in 1928 to succeed Prof. L. W. Lyde in London.

Fawcett was a leading member of the group of pupils of Mackinder and Herbertson who pioneered the modern development of honours schools of geography in British universities, and he was for many years prominent in the counsels of the Geographical Association, Section E (Geography) of the British Association, and the Institute of British Geographers, of which he was one of the founders and an early president.

A faith in the essential reasonableness of his fellow men, as well as his own rationalism, permeated all his work, and were revealed, for example, in his interest in the development of an auxiliary world language and calendar reform. They found particular expression in "The Bases of a World Commonwealth", published in the darkest period of the Second World War. His emphasis upon the unity of the Atlantic community combined with his personal qualities to make him a ready and welcome visitor to New England. Having already been visiting professor at Clark University, Worcester, Mass., in 1931 and again in 1947, he returned there for two years after retiring from the chair at University College, London.

It is perhaps too soon to attempt an assessment of his contribution to the development of geographical thought; but the significance of his early work, "The Provinces of England" (1919), in the history of the regional concept is already evident. That it should have been specifically written to point a reasonable basis for devolution of government and reform of administrative areas was typical of his essentially practical outlook. Geography claimed his absorbing interest not for its own sake, but also as a social science which in its application to social and political problems could increase the sum of human happiness. To the studies of population problems and political geography, which increasingly engaged his attention, he brought an insistence upon appreciating the realities of hard facts. His own command of facts was an unfailing source of wonder to his students, who will remember the encyclopædic knowledge on all manner of topics which illumined or diverted his lectures, as they will his unfailing kindliness and outstanding fairmindedness. A. E. Smailes

Prof. Aikitu Tanakadate

Friends and acquaintances of Prof. Aikitu Tanakadate will learn with regret of his death on May 21 in Tokyo, after a long and active life of ninety-five years.

He was born in 1856 at Fukuoka town in the present Iwate Prefecture, Japan. Entering the University of Tokyo in 1878, he studied physics under J. A. Ewing and T. C. Mendenhall, and afterwards under C. G Knott, who were at that time visiting teachers of the University. His interest was particularly directed towards geophysical phenomena, and soon after graduation he started gravimetric and magnetic surveys over Japan, which had not been explored scientifically by that time. "A Magnetic Survey of Japan", which was written by him with admirable thoroughness and completeness and was published in 1904, is universally known as a monumental work of this kind. In 1888 he went to Glasgow, where he studied physics as a pupil of Sir William Thomson (Lord Kelvin). He returned to Japan in 1891 and in that year was appointed a professor in the University of Tokyo, a post which he held until 1917.

Prof. Tanakadate was the oldest member of the Japan Academy of Science, an emeritus professor of the University of Tokyo, the first recipient of the Order of Cultural Merit, sometime vice-president of the National Research Council of Japan, and a member of the House of Peers. He also held important positions in many learned societies. For more than seventy years of his career as a scientist he literally devoted himself to initiating and promoting natural sciences in Japan. His activity covered fields in a wide range of subjects—to mention a few, geodesy, variation of latitude, seismology, terrestrial magnetism and aeronautics. Japan urgently needed such a pioneer as Prof. Tanakadate, particularly towards the end of the nineteenth century, after the Meiji Restoration of 1868, which brought to an end the three hundred years of Shogunate feudalism. His love of science as well as of his native country seems to have been the primary motive which drove him to this honourable duty. This does not mean that he was a man of narrow-sighted nationalism. On the contrary, he is known as a strong advocate of international friendship and co-operation. He travelled abroad no less than twenty-three times and attended

a number of scientific assemblies and presided at several of them. He was the first president of the International Association of Terrestrial Magnetism and Atmospheric Electricity. C. E. Guillaume, of France, is said to have one day announced with mock seriousness that the second moon was newly born; his explanation to rather puzzled hearers was this: "It is Prof. Tanakadate. He makes a revolution around the world every year".

Prof. Tanakadate was liked by everybody who had the opportunity of becoming acquainted with him, and admired for his unfading love of science as well as for his logical and brilliant way of thinking, intermixed occasionally with a good sense of humour. Many old friends all over the world will honour his memory.

CHUJI TSUBOI

WE regret to announce the following deaths:

Dr. W. E. Gye, F.R.S., lately director of the Imperial Cancer Research Fund, on October 15, aged sixty-eight.

Sir Frederick Keeble, C.B.E., F.R.S., formerly Sheradian professor of botany in the University of Oxford, on October 19, aged eighty-two.

NEWS and VIEWS

Sir William Ramsay and University College, London

REFERENCE has already been made (see *Nature*, October 4, p. 554) to the appeal for funds which has been made on the occasion of the centenary of the birth of Sir William Ramsay. The appeal was well and truly launched at a Ramsay Memorial Dinner held at University College, London, on October 15, at which H.R.H. The Duke of Edinburgh was guest of honour and proposed the toast "to the immortal memory of Sir William Ramsay". He took as his theme the importance of fundamental research and its significance for industrial progress, quoting from his experience of recent work going on in State research institutions, and using Sir William Ramsay's discovery of the rare gases as an example of the manifold and unsuspected uses which may be made in everyday life and industry of the results of fundamental research. The reply to the toast was made by Dr. B. Ifor Evans, provost of University College, who outlined the purpose of the appeal, and stated that £57,000 has already been promised towards the £100,000 which it is hoped to raise. During the dinner, it was announced that Lady Tidy (a daughter of Sir William Ramsay) and Prof. Morris Travers—both of whom, with other associates of Ramsay, were present—had decided to present to the College the collection of Ramsay letters, papers and other materials which Prof. Travers has been accumulating over a long period. Incidentally, it may be added that Prof. Travers has prepared a fascinating account of Ramsay's life and work which has been issued by the College in connexion with the centenary appeal.

The appeal is being issued jointly by the University College Committee and the Ramsay Memorial Fellowships Trustees. After Ramsay's death in 1916, funds were raised by public subscription and were devoted partly to building a chemical engineering laboratory in the College and partly for the endowment of Ramsay Memorial General Fellowships to enable advanced students of chemistry from any part of the world to carry out research at any approved centre in the United Kingdom. Fellows from overseas are supported by funds raised in the country of their origin, and in this way Canada, Denmark, France, Greece, Holland, Italy, Japan, Norway, Spain, Sweden, Switzerland and the United States have sent distinguished young students to Great Britain. Funds subscribed in Britain were mainly devoted to British students, and the capital fund available for that purpose is now inadequate to maintain the normal award of one fellowship of two-years tenure every year. It is therefore proposed to devote £25,000 from the £100,000 which the appeal is hoped to produce to augment the Fellowship Trust General Fund, so that the normal number of British fellowships may be restored. With the remaining £75,000 it is hoped to make a substantial addition to the laboratory accommodation at University College and to provide additional equipment. When Ramsay went to the College, the facilities for research were meagre. By his personal exertions he supplemented what was available to him in the College, until he led a famous school of research. He would surely have approved the purpose of this centenary appeal to industry and others to augment the resources of the College, so badly damaged during the Second World War, and to provide more funds for the maintenance of that world-fellowship of distinguished chemists who are proud to acknowledge their association with the Ramsay Memorial Trust.

The Royal Sanitary Institute: Dr. J. W. Dudley Robinson

AT a luncheon given in his honour on October 14, Dr. J. W. Dudley Robinson, who will be retiring at the end of this year, was presented with an inscribed silver rose-bowl and a cheque on behalf of the Fellows, Members and Associates of the Royal Sanitary Institute as a token of their appreciation of his valued service as secretary of the Institute since 1928. Dr. Robinson has also been secretary of the Royal Sanitary Institute and Sanitary Inspectors Examination Joint Board since 1928 and of the National Nursery Examination Board since its formation in 1945. Since he went to the Institute from the secretaryship of the Institution of Municipal Engineers, he has been responsible for much of the former's successful development. In addition to organizing the annual health congresses of the Royal Sanitary Institute, which are attended by upwards of two thousand delegates, he has also arranged a number of special conferences, notably on the Midwives Act in 1936, and on the administration of the Milk (Special Designations) Order in the same year. During his service with the Royal Sanitary Institute, Dr. Robinson has been responsible for its examination system under which some sixty-eight thousand candidates have been examined. In the same period, the membership of the Institute has increased from 4,700 to well over 9,500. In 1950 he was appointed an officer of the Ordre de la Santé Publique by the President of the French Republic.

New Fellowships in Microbiological Biochemistry at Oxford

THE University of Oxford has been able to establish three research fellowships in microbiological bio-

chemistry in the Department of Biochemistry, owing to the generosity of Arthur Guinness, Son and Co., Ltd., who have offered to pay the University £2,500 a year for seven years for this purpose. The Guinness Research Fellows must be British subjects who are graduates of a university and who have had experience in research. They will be appointed by the Board of the Faculty of Biological Sciences in the University of Oxford, on the recommendation of the Whitley professor of biochemistry and the reader of microbiology in the Department of Biochemistry. It is anticipated that Fellows will hold their appointments for three years, receive a salary between £600 and £800 a year and carry out fundamental research in the field of the biochemistry of micro-organisms.

Centenary of the Royal Photographic Society

The Royal Photographic Society of Great Britain will be celebrating its centenary next year and will hold an international conference on the science and applications of photography in London during September 19–25, 1953. The conference will cover many aspects of the science, technique and applications of photography and will be divided into five sections dealing with the following topics: photographic science—including the theory of the latent image and development, sensitization, sensitometry, resolving power, granularity and the properties of photographic materials; cinematography and colour photography; technique and applications of photography—including industrial radiography, photomicrography, spectroscopy, aerial photography, photogrammetry, high-speed photography, nuclear track recording, and other physical, chemical and biological applications, as well as photocopying and photographic apparatus, processes and manipulations; photomechanical processes; history, literature—including abstracting and documentation—and training in photography. All persons taking an interest in photography or its applications are invited to attend the conference, and to submit papers for discussion. Titles and indications of the scope of such papers should be submitted before February 1, 1953, and the full paper before May 1, 1953; it is intended to publish the papers in full before the conference. All communications regarding the conference should be addressed to the Honorary Secretary, R.P.S. Centenary Conference, 16 Princes Gate, London, S.W.7.

Isotope School at Harwell: Course of Instruction

Since the opening in April 1951 of the Ministry of Supply's Isotope School at Harwell, a steady succession of courses has been held there in the technique of handling and using radioactive isotopes. So far, a hundred and fifty scientific workers, medical men and engineers have passed through the school, nearly three-quarters being from Great Britain, and of the remainder one-third being from South Africa, India and Australia and the other two-thirds from European countries. The students come in nearly equal numbers from five main groups: universities, technical colleges and research institutions; industrial research laboratories; industry; medical centres; and the Department of Scientific and Industrial Research and government departments. Nearly two-thirds of the total have been chemists and biochemists, and the remainder have been made up of engineers, physicists and medical men in roughly equal proportions. During the sixteen months of its existence the School has continually developed and attempted to have in its laboratories equipment which is abreast of the very latest developments all over the world. To house the additional equipment the School was moved from its original quarters, a converted wooden hut, and has, since January of this year, been installed in a permanent brick building where there are now ample facilities for carrying out all the physical and chemical manipulations required when working with radioisotopes. The courses last for four weeks, and in that time, by means of lectures and especially by working in the laboratory, a sound grounding in the principles of working with radioactive materials is given; the training is intended to be of a fundamental nature and does not deal with the very specialized techniques which have been developed for application in industry and medicine. The next courses in the School will begin in January 1953, and applications for admission and further information can be obtained from Dr. J. E. Johnston, Isotope School, A.E.R.E., Harwell.

Revival of Japanese Botany

Evidence that the vigorous interest in botanical science that was a feature of pre-war Japan is renewing itself is shown by the publication of "An Address Book of Japanese Botanists" (1951), edited by the National Committee of Botany, and published by the Science Council of Japan, Tokyo (no detailed address given). Some 350 names are given, with ages, addresses, qualifications, interests and publications, and the object is "to recover and further promote our scientific friendship with foreign botanists and relevant societies".

New Photoelectric Absorptiometer

The firm of Hilger and Watts, Ltd. (48 Addington Square, London, S.E.5), has recently started to produce a new photoelectric absorptiometer to be known as the 'New Biochem Absorptiometer'. It is a compact direct-reading instrument of the single-cell type designed for routine use in the laboratory. The controls comprise an on–off switch, a light control for setting the full scale reading, a shutter for the photocell, and a filter selector drum. The latter contains eight spectrum filters of narrow band-width. The photocell is connected to a sensitive reflecting galvanometer the white opaque screen of which enables readings to be taken more easily than with the usual semi-transparent type. Flat-sided cells or special test-tubes can be used, the mount for the latter being optically compensated for the refractive index of the solution. Spilt solutions merely drop through to the work bench; also the cell mounts are made of polythene. The instrument is either battery- or mains-operated with built-in constant-voltage transformer.

Inter-Library Microfilm Catalogue of the Scientific Libraries in Israel

A bi-lingual guide (in English and Hebrew) to the Inter-Library Microfilm Catalogue of the Scientific Libraries (Natural and Applied Sciences) in Israel has been issued by the Research Council of Israel, Jerusalem (pp. 100; 1952). The catalogue itself is the first part of a scheme to improve the scientific information services of Israel, and, for the present, copies are distributed only to the Research Council of Israel, Jerusalem, the Hebrew University (Terra Santa, Jerusalem), the Agricultural Research Station (Rehovot), the Bett Gordon Library (Dagania A), the Hebrew Institute of Technology (Haifa), and the

Engineers Institute (Tel Aviv). The guide indicates the scope of these libraries and the classification used in their several catalogues, so that application for the appropriate section of the microfilmed catalogue is facilitated. The present format and pagination of the guide are cumbersome and inconvenient to the user; the bi-lingual reports by, for example, the National Research Council of Canada or the South African Council for Scientific and Industrial Research are in a much better style.

Institute of Education Library, Birmingham

THE Institute of Education Library, University of Birmingham, has issued a Supplement (No. 1, pp. 83; February 1951–March 1952) to the basic catalogue of 1951, mainly for the assistance of readers who cannot visit the Library. Items of less than 51 pages are indicated by the symbol [P]. The entries are classified under such heads as, for example, reference books (which cannot be borrowed), history of education, principles and philosophy of education, sociological aspects of education, national systems of education, universities and university education, adult education, vocational guidance, the curriculum, exceptional children, etc. A complete list of the Library's holdings of periodicals is included, and there is an author index.

Institute of Metals: New Officers

THE following have been elected to fill vacancies on the Council of the Institute of Metals, with effect from the annual general meeting in 1953: *President*, Prof. F. C. Thompson (professor of metallurgy, University of Manchester); *Vice-Presidents*, Major C. J. P. Ball (chairman, Magnesium Elektron, Ltd.) and Prof. G. V. Raynor (professor of metal physics, University of Birmingham); *Members of Council*, W. A. Baker (research manager, British Non-Ferrous Metals Research Association), J. C. Colquhoun (chairman and managing director, Manganese Bronze and Brass Co., Ltd.), E. R. Gadd (chief metallurgist, Engine Division, Bristol Aeroplane Co., Ltd.) and the Hon. John Grimston (director and general manager, Enfield Rolling Mills, Ltd.). The Council of the Institute has elected Dr. S. F. Dorey (chief engineer surveyor, Lloyd's Register of Shipping) to serve as senior vice-president for the year 1953–54, and he will be nominated for the presidency for the year 1954–55.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have recently been announced: D. F. Davidson (assistant conservator of forests, Cyprus), senior assistant conservator of forests, Cyprus; J. K. Ross (assistant conservator of forests, Sierra Leone), assistant conservator of forests, Nigeria; J. M. Waterston (senior botanist, Nigeria), principal research officer, Agricultural Department, Nigeria; J. D. Birkett (senior veterinary officer, Nigeria), director of veterinary services, Sierra Leone; G. F. Darnell, agricultural officer, Federation of Malaya; G. E. Dixon, plant breeder, Kenya; P. Greening, agricultural officer, Northern Rhodesia; W. G. Plaistowe, agricultural officer, Nyasaland; R. M. Sister, entomologist, West African Cocoa Research Institute, Gold Coast; M. E. H. Vickers, agricultural officer, Kenya; P. E. Wheatley, agricultural entomologist, Kenya; R. C. Norris, chemist, Federation of Malaya; J. A. B. Stewart, geologist, Somaliland Protectorate; L. A. J. Williams, geologist, Kenya; A. D. McKelvie, plant physiologist, West African Cocoa Research Institute, Gold Coast; G. R. Robson, scientific officer, Trinidad (seismological observer in charge of recording station, Windward and Leeward Islands); D. J. Taylor, entomologist, West African Cocoa Research Institute, Gold Coast; R. Wilson, veterinary officer, Somaliland Protectorate; P. H. Gulliver, sociologist, Sociological Research Provincial Administration, Tanganyika; H. F. Lamprey, biologist, Game Department, Tanganyika; N. G. Shaw, assistant conservator of forests, North Borneo; R. Tavener-Smith, geologist, Northern Rhodesia; G. Webbe, entomologist, Medical Department, Tanganyika; E. Wigura, computer, Surveys and Town Planning Department, Tanganyika.

Announcements

PROF. M. VON LAUE, who will be addressing a meeting of the Physical Society at 5 p.m. on October 29 at the Science Museum, South Kensington, London, S.W.7, will first present the Max Planck Medal for 1952 to Prof. P. A. M. Dirac on behalf of the Association of German Physics Institutes.

MR. N. D. RILEY, keeper of entomology in the British Museum (Natural History), is relinquishing the editorship of *The Entomologist*, a post he has held for thirty-one years, and will be succeeded in the new year by Mr. D. Leston. The journal is to be increased in size and widened in scope to include all aspects of pure and applied entomology; all inquiries regarding it should be directed to the editor at 44 Abbey Road, London, N.W.8.

THE National Science Foundation (2144 California Street, N.W., Washington 25, D.C.), in co-operation with the University of Chicago, is organizing a conference on the "Abundance of the Elements", to be held at the Yerkes Observatory, Williams Bay, Wisconsin, during November 6–8. The conference will bring together some forty leading astronomers, chemists, geochemists and physicists, drawn from university, industrial and government research organizations, who will consider the effect of recent research in stellar and terrestrial measurements on current theories of the abundance of elements in the universe. It is hoped that, as a result of this conference, fresh light will be brought to bear on the origin and material limits of the universe.

A FELLOWSHIP and a number of scholarships for work on arctic or sub-arctic research are being offered jointly by McGill University and the Arctic Institute of North America, with the financial support of the Carnegie Corporation of New York. The fellowship, which is worth 4,000 dollars, is for a senior research worker who has completed his studies in the field and requires a year's residence in a centre of learning to prepare his results or acquire specialized knowledge. The scholarships are normally tenable for one year, being worth on the average 750 dollars with 1,500 dollars field expenses, and are for graduates intending to undertake active field research. Further information regarding these awards can be obtained from the Carnegie Arctic Program, Arctic Institute of North America, 3485 University Street, Montreal, P.Q. Applications must be sent in by January 1, 1953, except that scholarship candidates not intending to do field-work in the summer of 1953 need not send their applications until April 1, 1953.

EXHIBITION OF THE WORK OF W. STANLEY JEVONS

By Dr. W. MAYS and Dr. D. P. HENRY
Department of Philosophy, University, Manchester

IN *Nature* of January 27, 1870, Jevons's paper "On the Mechanical Performance of Inference" read before the Royal Society in the previous week was reported. The paper is a historic one, as it contains an account of the first logical machine. Built in 1869, this was used for teaching purposes while Jevons was at Owens College (now the University of Manchester) and in London. It was eventually deposited in the Museum of the History of Science, Oxford, and has been lent to the Philosophy Department at Manchester, which has arranged an exhibition in the Christie Library of the University (October 15–31).

The exhibition shows that the truth-table method of solving logical problems was introduced by Jevons in 1864. Indeed, without the use of this method he could not have constructed his logical machine. Mary Hesse, in her recent study of Boole's unpublished manuscripts (*Annals of Science*, March 1952), after speaking of Boole's attempt to arrive at a non-algebraic expression of his logical calculus, says (p. 79): "The suggestion was developed independently by Jevons, who solved Boole's general problem without the use of algebra by writing down all possible combinations of the terms. . . . The result is in the form of a truth-table from which any question regarding terms or combinations of terms can be answered. Jevons made this the basis of his logical machine. It is clear from the MSS. that although Boole was feeling after some such method, there is no real anticipation of Jevons in his work". Further light is thrown on this matter by a series of unpublished letters in the exhibition, containing an exchange of views between Boole and Jevons on the publication of the latter's "Pure Logic". Boole's letters confirm Miss Hesse's judgment that it is to Jevons that we owe the introduction of the tabular method which led to his mechanization of logic.

Allen Marquand (1853–1924), fellow in philosophy, Johns Hopkins University, and afterwards professor of archæology and the history of art at Princeton University, constructed an improved four-variable machine (*Proc. Amer. Acad. Arts and Sci.*, 1885). Letters of Marquand in the exhibition show his indebtedness to Jevons. Marquand's manuscripts, now in the Princeton University Library, were examined by Prof. Alonzo Church, the well-known logician, who selected the material on logical machines, photostats of which are included in the exhibition. There are details of an eight-term machine, a syllogistic variation machine, and notes showing the advantages of Marquand's machine over that of Jevons. A copy of Marquand's wiring diagram for a four-term electrical machine was also sent. Prof. Church thought it important for us to see it, as it was not mentioned in any of the published papers he could recall. The diagram is of great interest; prepared about 1885, it is probably the first circuit of an electrical logical machine. It is wired in series and parallel, and among its components are sixteen electromagnets, eight one-way switches, one three-way switch, and a rheostat. Jevons's principles thus received their electrical translation at least half a century before present developments in relay computing machines.

Exhibited together with Jevons's machine is the modern three-variable electrical relay computer built for the Philosophy Department of the University of Manchester by Messrs. Ferranti (see Mays and Prinz, *Nature*, 165, 197; 1950), based on similar logical principles. Jevons's machine to-day is as portrayed in the frontispiece of the "Principles of Science". It looks like a miniature upright piano; on both the front and back are slots through which can be seen the letters representing the sixteen possible combinations of the four terms *A*, *B*, *C* and *D*, and their negations, thereby constituting a truth-table. It has a keyboard with twenty-one keys for terms and operations, by means of which the machine rods which bear these combinations can be classified, selected or rejected. The machine can deal with 65,536 possible logical selections. As the original report in *Nature* in 1870 says: "When once a series of propositions is thus impressed upon the machine, it is capable of exhibiting an answer to any question which may be put to it concerning the possible combinations which form any class. The machine thus embodies almost all the powers of Boole's logical system up to problems involving four distinct terms . . . demonstrating in the simplest and most evident manner the character and powers of a universal system of logical deduction, of which the first, although obscure solution, was given by Dr. Boole."

Jevons's logical notebooks are also exhibited. In one of them he works out all the 256 possible logical selections generated by three terms. They are displayed in the form of four panels drawn on graph paper. The notation is a binary one: dots indicate the existence of a combination, spaces their absence. In the "Principles of Science" (2nd edit., p. 135) and in some of his notebooks, he uses the 1 and 0 notation which has become so familiar to-day in logical and mathematical computers.

The exhibition also includes the manuscripts of many of Jevons's writings on economics and logic, and copies of his published works. Of direct interest to the economist are coloured charts of great complexity prepared for his "Statistical Atlas". There are letters from Gladstone, Bagehot, J. S. Mill, H. Spencer, Galton, Babbage, Venn, C. S. Peirce and many documents of economic interest. Notes on his experiments on Brownian motion (1878) further illustrate the variety of his interests. His journal during 1853–67, parts of which have appeared in the "Letters and Journal" edited by his wife, is also to be seen, as well as his drafts of class reports at Owens College, his memorandum books, personal reference books, photographs taken during his stay in Australia and family and University photographs.

W. Stanley Jevons was born in Liverpool in 1835, and died at the early age of forty-seven in 1882. He was professor of logic, mental and moral philosophy, and Cobden professor of political economy in Owens College (1866–76), and professor of political economy in University College, London (1876–80). To Jevons are due many important innovations in economics and logic; these, together with his researches in numerous other fields, reflect his versatility and brilliance.

The exhibition of the Jevons manuscripts and correspondence has been made possible by the kindness of his son and daughter, Mr. H. S. Jevons and Miss H. W. Jevons. Mrs. Eleanor Marquand Delanoy gave permission for the use of her father's manuscripts, and Dr. Tyson, librarian of the University of Manchester, allowed the use of the Christie Library for the exhibition.

TRANSPORT IN GREAT BRITAIN

IN a paper on "The Troubles of Transport", read on September 9 to Section F (Economics) of the British Association at the recent meeting in Belfast, Prof. C. F. Carter (professor of applied economics in Queen's University, Belfast) discussed some current problems of road and rail transport in Great Britain. Figures were quoted showing that transport is an expanding activity (thus making adjustment easier); that it is mostly by road; and that 45 per cent of the 'activity' of transport is organized as an ancillary to some other activity. "It is most unlikely," said Prof. Carter, "that the ownership of ancillary vehicles would have developed to this point if it were not an efficient way of organizing transport. There is . . . no evidence that it would be advantageous to break it down. It follows that the possible field for public ownership of the carriage of goods by road is only a minor part of that activity."

The discussion of transport problems in the past year, continued Prof. Carter, has been concentrated on organization and ownership, and has avoided the fundamental issues, which are the relation of charges to costs, the problem of public obligation, and the principles of taxation of road transport.

In theory, the charge for an item of transport should be proportional to the cost of providing an extra unit flow of transport service of that type, when the system has been fully adapted to supply the extra services effectively and conveniently. The ratio of two charges should equal the ratio of costs, taking no account of interest on the cost of 'permanent' assets such as the road bed. The difficulty of costing transport services is very great, and the results must be in part arbitrary. With the railways, enough is known to show that "the present pattern of charges not only bears no relation to costs, but often works the other way". On the road, the difficulty is to find a true economic cost when taxation is so important. Prof. Carter pointed out that "the 'cost' of the roads should for our purposes mean the cost of maintaining and improving them so that next year they can carry traffic as speedily and safely as this year"; with road vehicles increasing in number by 5 per cent per year, this cost would much exceed the sums at present being spent on maintenance. A National Roads Council is needed, charged with the duty of advising on road development and of keeping running estimates for five years ahead of the least expenditure necessary to maintain the roads and to adapt them to expected traffic requirements. Part of the taxation of road vehicles should be segregated as a Roads Tax, paid into a revived Road Fund, which would be autonomous and would carry forward balances from year to year. The Fund should receive what the National Roads Council estimates to be the proper sum to be spent on the roads—whether or not the economic situation allows this amount to be actually spent.

"A more fearsome dragon now lies in our path, called the Public, who are supposed to insist on various uniformities which flatly contradict the principles we have been discussing." Thus rail passenger fares are expected to be proportional to distance, whereas they should be tapered. Uniformity of rates over the whole of a public organization's system prevents any reflexion of the large differences in cost between different routes. Proposals for dealing with this on the railways were made in Prof. Carter's paper.

After traders have chosen to carry what is convenient to them in their own vehicles, and road hauliers have given preference to profitable traffic, the common carrier by road or rail is left with the odd lots, the awkward cross-country journeys; in particular, the railways are left with precisely the traffics which economically they are least fitted to handle. "If we reject any solution to this problem which involves forcing users to use a particular kind of transport, there seems to me to be only one solution: substantial differential taxation of those parts of transport which have the privilege of choosing their traffic."

The proper taxation of road transport thus has four parts: the general requirements of the Chancellor of the Exchequer; a tax on petroleum, as long as the state of the balance of payments is deemed more grave than the coal supply; a roads tax; and a levy on those not accepting public obligations.

Towards the end of his paper, Prof. Carter remarked: "I think we need a cooling-off period, to help transport to recover its commercial commonsense after a surfeit of politics; and the best cooler would undoubtedly be a weighty Royal Commission, charged with the duty of giving the whole matter up-to-date and careful study".

SHAPES OF AEROPLANE WINGS

A PAPER on "The Shape of Wings to Come", by Mr. D. Keith-Lucas, chief designer of Short Bros. and Harland, Ltd., was read on September 8 before Section G (Engineering) of the British Association at the recent meeting in Belfast. The paper has since been published in full in *Engineering* (174, 349; 1952). It is of considerable interest as it goes a long way towards explaining the departures from orthodoxy of wing form which can be seen daily by persons who live near certain airfields.

Mr. Keith-Lucas explains that the main purpose of sweep-back is the reduction and the postponement to higher speeds of compressibility effects normally met with on straight wings at high subsonic speeds. The velocity of the wing relative to the air may be resolved into components normal to and parallel to the span. It is shown that the main aerodynamic effects are fixed by the former, so that the effective air speed of the wing can be made low by the use of sweep. End effects, at the root and the tips of the wing, reduce this benefit by half. It is also shown that at high supersonic speeds the unswept wing can be made efficient again, providing only that it is very thin; for example, the thickness of the sections may have to be as little as 3 per cent of the chord. Sweep-back was first introduced, however, in order to stabilize the all-wing aeroplanes which it was hoped to use before the penalty of severe drag of the

resulting thick wing was fully appreciated. There is an interesting discussion in the paper of an Australian project for an all-wing airliner using a 30 per cent thick wing fitted with boundary-layer suction in order to reduce the drag.

The thin swept-back wing is shown to be peculiarly susceptible to aeroelastic effects; that is, to the aerodynamic consequences of structural distortion in flight. A simple example of such an effect is the so-called aileron reversal. This is also met in unswept wings. If the extra lift produced by the downward deflexion of an aileron acts towards the rear of the wing, it produces a 'nose down' twist of the structure which will cause a net loss of lift at sufficiently high speeds. An academically interesting solution to the general problem is the 'aeroisoclinic' wing invented by G. T. R. Hill. This leads to a swept wing which is weak in torsion. Aileron reversal is to be avoided by obtaining lateral control from wing tips the incidence of which to the wind can be varied, instead of the conventional ailerons. The case for crescent wings is also made. It seems, however, that at moderate supersonic speeds there is little to beat the delta planform with its large internal volume, especially at the wing root. This allows ample space for a stiff structure, the load, the fuel, the undercarriage, and the whole variety of apparatus and equipment carried by modern aeroplanes.

It is a big problem to get highly swept wings to give adequate lift at slow speeds, and the possible solutions of the landing problem are the subject of controversy among aeronautical scientists and engineers. An American aeroplane with sweep which is variable in flight has recently been flown. There are advocates of the use of parachutes, stowed helicopter blades, etc. In fact, the shape of wings to come is as yet indeterminate because of the difficulties of flying slowly.

HARNESSING KNOWLEDGE

ANNUAL CONFERENCE OF ASLIB

THE fact that Aslib could choose "The Significance of Information in Present-Day Industrial Society" as the theme of its twenty-seventh annual conference, held recently at Swanwick in Derbyshire, clearly indicates that the day is past when 'information' could be dismissed as the concern of the chemist or physicist alone. The very phrase has an Aristotelian ring that nevertheless yields nothing in emphasis to the twentieth century's pre-occupations with men as minders of machines. So, indeed, it should be, for as Sir Stephen Tallents declared in opening the conference, "ideas have to-day become not only the most potent of forces but also the most precious of cargoes". Those same ideas, communicated and applied, are the life stream of an industrialized society, which must perish unless it can produce more goods more cheaply than ever before.

In this modern industrial and scientific society, the key to future development is the speed with which new ideas can be put to work—such was the burden of the principal paper at the conference, presented by Prof. T. U. Matthew, who holds the chair of engineering production in the University of Birmingham—the only one of its kind in Great Britain. We have, he said, achieved a new type of chain-reaction in which new knowledge and ideas, travelling at a rate governed by the effectiveness of our information services and means of publication and communication, give rise to an endless succession of transmutations and further ideas in an ever-widening range of specialized fields of research and development. For the truth of this, one need not look beyond the post-war capital development programmes in coal, steel and chemical production, which have all felt the impact of modern methods of communication on a large scale.

These, it is true, are fields in which, for the most part, large industrial units are engaged. It is encouraging to know that, according to the recent survey "Research and Development in British Industry", produced by the Federation of British Industries, some £30,000,000 is now being spent on research each year compared with £5,500,000 just before the Second World War. But responsibility for bringing into the production stage the vast stores of new knowledge that become available in this way still lies generally with a comparatively small group of larger companies. Behind them stretch the thousands of firms of intermediate and smaller size, the majority of which have not, as yet, got to grips with the concept of increasing productivity, let alone the definitive shape that can be given to that concept by the utilization of published facts and figures. Add to this picture of the production side of industry the stimulus that can come from the communication of data and ideas in connexion with home and foreign markets, internal and external freight facilities, international trade and currency regulations and, not least, industrial labour relations—the vision is stirring indeed.

Here, as Prof. Matthew indicated, arise both the immediate obstacle and the long-term challenge. It is already clear, he said, that the present rate of discovery arising from fundamental research in physics, chemistry and the applied sciences, far exceeds the digestive capacity of existing development resources—hence the growing pressure for a new technological university and more technologists to bridge the gap between scientific research and industrial application. On a wider stage, the rate of exploration of the world's raw material resources has outstripped the nations' capacity to finance and organize their development. To this fact can be traced such schemes as the United Nations technical assistance projects, the 'Point 4' plan of the U.S. Government and the Colombo plan. Both nationally and internationally, these far-sighted proposals mean a mounting pressure on information services. Steps to encourage the interchange of knowledge and to speed up the processes of accumulating, abstracting, classifying and disseminating information on research and technical developments, production processes, raw material resources and market opportunities have already been taken, nationally, by Aslib, the Department of Scientific and Industrial Research and the research associations and, internationally, by the Office for European Economic Co-operation and the British Commonwealth Scientific Offices. The danger is that, in the smaller firms which have not yet established information departments of their own, these existing facilities may pass unnoticed, at least until the supply of technologists has increased. For the immediate future, he said, it is a question of assisting individual managers, who are not yet alive to the great wealth of recorded information open to them, to exploit it with only their present resources of staff. To Henri Fayol's six activities of management of fifty years ago, it is now time to add a

seventh—the information function; and on the performance of it in the next decade or so the long-term future of British industry may well depend.

If, indeed, information services are destined to play such a crucial part in the future of British industry, much of the credit for an early realization of their potential value must go to the Royal Society's Information Services Committee and to Aslib, the work of both of which since 1948 was reviewed in papers presented by Dr. D. J. Urquhart and Mr. Leslie Wilson. The story of their achievement in barely four years is, perhaps, one of the most creditable on the less sensational side of British recovery since the War. Yet there can be no room for complacency while it can be said, as Dr. Urquhart did, that "there do not appear to be any major faults in the system [that is, of information services] as significant as the fact that so many who might use the system more, hardly use it at all". A recent survey indicated that 75 per cent of all industrial organizations have less than five periodicals of any sort and less than fifty books. At the same time, it has never been clearly demonstrated that the kind and size of firms that one might reasonably expect to find among the 75 per cent could and should be able to make use of published information on a scale likely to affect turnover materially. The firms themselves are mostly inarticulate or unaware of their need of information, technical or otherwise. The next step is surely to reduce this diffuse problem to measurable proportions, to ascertain at what level information services should operate in order to make the greatest contribution to the numerous and varied groups of potential information users. This is research of a kind in which, it is to be hoped, Aslib may be enabled to give an early lead.

MINERAL DRESSING

SYMPOSIUM IN LONDON

AT the beginning of this century the extraction of valuable minerals from their host rocks and ore complexes was a craft rather than a science. With the mounting demand, first for more and more engineering metals, and later for alkali earths and the oxidized earths of the rarer metals, it became necessary to exploit low-grade ore-bodies hitherto considered uneconomical. Two World Wars accelerated industrial demand, and at the same time forced the crude processes of those days on to a more scientific basis. It is a far cry from the 'préparation mécanique' and the 'ore dressing' of the past generation to the precise process engineering of the modern mineral-dressing plant. A satisfactory title for the wide range of activities embraced by this phrase 'mineral dressing' remains to be found. Treatment starts with the reduction of large pieces of rock to an average particle size of anywhere down to a few microns, and then uses such forces as gravity (simple or reinforced by centrifugal acceleration), magnetism and electrostatic deflexion, and, above all, the differences between the surface tension effects on minute particles in order to render them amenable to the froth flotation process and allied techniques. The field of application in industry is constantly being enlarged by the fundamental technological research work now actively in process in a number of laboratories. This again is reflected in the increasing exploitation of ore deposits hitherto considered too low in grade to be worth treating. Industrial specialization has moved mineral dressing into the position where it takes over practically everything produced underground or in open-cast work and rejects suitable quantities of valueless material, while bringing up the balance to a closely controlled specification which aims at optimum technical preparation for subsequent processes such as smelting or leaching, the production of a variety of finished substances (for example, asbestos) or the purification of such earths as phosphates to the point where wet chemical processes can best be applied to the upgraded concentrates.

Evidence of the wide scope of these technical developments was supplied by the first symposium on mineral dressing ever to take place in Great Britain, which was held during September 23–25 under the auspices of the Institution of Mining and Metallurgy at the Imperial College of Science and Technology, London, an inaugural lecture (the Sir Julius Wernher Memorial Lecture) being delivered at the Royal Institution the previous afternoon by Prof. A. M. Gaudin (see *Nature*, October 18, p. 656). Thirty-nine papers were presented, covering the international field of research and application. Size, surface area, shape and lattice structure were brought together in a series of papers which dealt with discontinuity lattices and their effects on minerals chemically almost identical. The mathematics of crushing and grinding are at present statistical rather than fundamental, and are showing that the hypotheses of Kick and Rittinger, which during the past century have aged unobtrusively into 'laws', are not entirely satisfactory. Papers on comminution and precise measurement of products down to the 5-μ range discussed the role of stresses shown at the surface of the particle as 'crack tips', and defined and described the principles and laboratory techniques now available for the measurement of sizes and surface areas of the crushed products. Sub-sieve methods using sedimentation and elutriation in gaseous and liquid columns were compared. The practical aspects of this work in its extension to process control were covered in another group of papers. One important aspect of this branch of technical research is its use in the reduction of huge tonnages of low-grade ore to a closely controlled size-range of particles having a suitably differentiated condition at their individual surfaces as a prelude to separation by froth flotation, a process which can operate in suitable cases with high efficiency on particles as small as 3 or 4 μ in diameter.

The limitation of 'heavy media separation', as the process is industrially called, has been progressively reduced until to-day suitable material down to 20 mesh (Tyler) can be treated, although such a small size is exceptional. In one of the papers describing plant operation, a daily tonnage of 12,800 was mentioned, treating diamondiferous 'blue clays' down to 10 mesh by this method. The operating characteristics of the hydro-cyclone received new elucidation in two papers. This instrument applies controlled centrifugal force to a moving stream of particles and aids them to segregate in accordance with their difference of mass. Provided there is a marked difference of density in the + 100-mesh field, simple gravitational force can be used for this work; but as the Newtonian laws of settlement give place to Stokesian sedimentation, accelerated gravitational fields must be used if large quantities are to be handled quickly. The

fundamental work of the Dutch and British laboratories in this intricate research is important. Two papers reported developments in the use of air as a commercial separating medium in desert country.

The largest group dealt with the froth flotation process, at all levels from that of the fundamental worker in surface chemistry to that of the specific problems handled in exploiting plants. The physics of frothing, aeration and attachment of a hydrophobic particle to an air-bubble in water were well represented. The effects of minute traces of soluble ions on the specific development of hydrophilic and hydrophobic surfaces were also considered. Other papers dealt with ion-migration study involving radioactive isotopes and the application of electrochemical methods to flotation research.

The present position of magnetic, electrostatic and photometric techniques was discussed in three papers. A striking symptom of change is the fact that only one paper dealt with the chemistry of cyanidation, although two others discussed plant practice in gold extraction. If mineral dressing had been of sufficient importance twenty years ago to bring together an international gathering of this calibre, the cyanide process might have dominated the scene. Even on the Rand, where the technology was first established, the main interest is now in the flotation of uranium from cyanide tailings—a process still on the secret list and therefore not presented at this symposium. Among the papers dealing with commercial practice was one on lead–zinc concentration, one on a gold–copper–zinc–pyrite complex, one on the design of small plants and one on the milling of asbestos.

The symposium brought a large gathering of scientific workers and engineers from all over the world, and discussion and interchange of views were sustained at a high level throughout the three days of the meeting. Appropriately to the occasion which had brought so distinguished a gathering of experts to Britain, the partly completed sections of the reconstructed Bessemer Laboratory of the Royal School of Mines were open. The 1910 layout, which contained what may have been the earliest pilot plant for industrial teaching and research, is being modernized to meet the need for specialized training of students and to provide further facilities in Britain for research in ore concentration, one development of which is the new degree course of the University of London in mineral dressing. E. J. Pryor

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NEW RESEARCH TECHNIQUES IN PHYSICS

SYMPOSIUM IN BRAZIL

A SYMPOSIUM on "New Research Techniques in Physics" was jointly organized by the Academia Brasileira de Ciencias and the Centro de Cooperación Científica para América Latina (Unesco) and was held in Rio de Janeiro during July 15–22 and in São Paulo during July 24–29. The meeting had a double purpose: to provide for Latin American physicists an opportunity of discussing their problems, as part of a more general programme of the activity of Unesco in Latin America, and to stimulate and help the development of modern research in Brazil, by inviting a number of distinguished foreign scientific workers. The meeting was sponsored by the Conselho Nacional de Pesquisas (National Research Council; president, Admiral Alvaro Alberto), and, in São Paulo, by the University of São Paulo.

The number of foreign participants was very encouraging, and Latin American physicists came from Argentina, Bolivia and Mexico, of whom the strongest group was that from Mexico, giving seven papers out of a total of sixty-seven. Prof. M. S. Vallarta (Mexico) reported on an injection mechanism of charged particles due to the variable magnetic field of sunspots. He pointed out that protons in a sunspot could be accelerated up to 6×10^9 eV., while electrons, in the same field, would lose most of their energy by electromagnetic radiation.

I. Escobar (Bolivia) reported on work he had done at Echo Lake on the east–west asymmetry of positive and negative mesons. He expects to be able very soon to continue this work on the geomagnetic equator, at the high-altitude station at Chacaltaya (5,300 m.) which will be operated jointly by the Universidad Mayor de San Andrés (La Paz) and by Dr. C. Lattes, Centro Brasileiro de Pesquisas Físicas. Two papers were read by Argentine physicists: K. Fränz has constructed in Buenos Aires an electronic multiplier, which gives 1,000 multiplications per second with a precision of about 1 per cent; and R. Gans showed how he has been able to solve Hallén's integral equation for the current in a linear antenna in the neighbourhood of resonance frequencies, obtaining a remarkable agreement with experiments.

Prof. J. Costa Ribeiro (University of Brazil) gave a detailed report on a new phenomenon which he has called the thermodielectric effect. He has found that the transition of many dielectric substances from the solid to the liquid state is accompanied by a weak electric current. In the case of naphthalene, the effect is of the order of one electron charge liberated for 10^{10} molecules passing from one phase to the other. Prof. Ribeiro pointed out that the detailed mechanism of the phenomenon is, however, not clear and that it has not yet been possible to establish to what degree the effect is characteristic of a pure substance and how it becomes, eventually, influenced by adding foreign ions.

Several papers dealt with work in Prof. B. Gross's laboratory at the Instituto Nacional de Tecnología. Prof. Gross reported briefly on the behaviour of an electret under variation of temperature and, in another communication, dealt with the work which leads him, alternately, to consider the transformations which connect creep and relaxation of elastic substances and admittance and impedance of electric circuits. He also dealt with electric networks connected either in parallel or series. H. Barbosa (University of São Paulo) reported on certain semiconductors which he has found to be very sensitive to elastic deformations. Prof. R. M. Fuoss (Yale University), who spoke in Portuguese, gave an account of work on polyelectrolytes, in which large polymer molecules carry several charged atoms. Chain molecules are known to influence the viscosity of a solution and, in the case of polyelectrolytes, electrostatic forces, which modify this influence, have to be considered.

A considerable fraction of the symposium was devoted to new apparatus. In the inaugural session H. L. Anderson reported on the new 170-in. synchro-cyclotron at Chicago, and D. W. Kerst (University of Illinois) described the three betatrons which are now in operation in Urbana, reaching X-ray energies

of 22, 80 and 320 MeV. M. D. Sousa Santos (University of São Paulo) reported on the betatron which he has put into operation in São Paulo and which furnishes X-rays up to 29 MeV.; it is the first instrument of that power which has been set up in Latin America. A series of communications of his collaborators dealt with results which have been obtained so far with the São Paulo betatron, using the excitation function of ^{63}Cu (γ,n) ^{62}Cu in order to test the energy spectrum and the angular distribution of the X-ray beam.

R. G. Herb (University of Wisconsin), F. Alba (University of Mexico) and O. Sala (University of São Paulo) discussed electrostatic generators. In Mexico a 2-MeV. Van de Graaff generator, made in the United States, has been put into operation, while the São Paulo generator, designed to give 3·5 MeV., is still under construction. J. Marshall (University of Chicago) described his Čerenkov counter for cosmic rays, and this was followed by a number of papers dealing with experimental observations noted during the construction of Geiger–Müller counters. S. de Benedetti (Carnegie Institute of Technology) described a coincidence circuit which, in connexion with scintillation counters, permits him to obtain a time resolution of 10^{-9} sec., sufficient to determine the time of flight of a gamma-ray quantum over a distance of a few centimetres. P. Ribeiro de Arruda (University of São Paulo) showed a diffusion cloud chamber operating at a constant temperature gradient.

G. P. S. Occhialini (Brussels) replaced his report on nuclear emulsions by a more detailed seminar in that field. The results which were communicated at the symposium showed clearly four different lines along which modern physics is progressing, namely, modern quantum electrodynamics, nuclear forces, mesons and high-energy phenomena.

Dealing with the first of these, though modern quantum electrodynamics was not represented at the meeting, it intervened in the report of M. Deutsch (Massachusetts Institute of Technology) on positronium. The transfer of momentum between an electron and positron by means of virtual annihilation was studied many years ago by Bhabha, and its influence on the hyperfine structure of the electron–positron system has been discussed by J. Pirenne. But when Dr. Deutsch recently succeeded in determining this hyperfine structure by registering the annihilation radiation of positronium-levels, he not only verified directly the existence of these forces, but he was also able to measure the radiative corrections for them. Dr. de Benedetti has been able to measure the life-time of positrons in metals and has found the surprising result that this life-time does not depend on the particular metal used. He has also been able to register three photon disintegrations of positrons, a phenomenon which, in agreement with theory, is about 370 times less frequent than two photons disintegrating. We can already expect that a new chemistry will be found, one in which hydrogen becomes substituted by positronium, though the substances to be studied will have an extremely short life-time.

Nuclear forces were dealt with in Prof. E. P. Wigner's report. Recent work in Princeton University has led him to the conclusion that the strong spin-orbit coupling, characteristic for the nuclear shell model, can be understood, at least by sign and order of magnitude, as a result of the action of central and tensor forces. A similar result has been found by R. Oehme (Instituto de Física Teórica, São Paulo), who considered the motion of a nucleon in the pseudoscalar meson field of a core. Prof. Herb described the precautions he has had to take in order to make sure that at 4·2 MeV. a small amount of proton scattering appears in the proton–proton collision. Prof. Kerst mentioned in his report the possibility of studying the photodisintegration of deuterons in the energy-range 150–300 MeV.

Important progress has been made in the study of the meson field. A target, beryllium, aluminium or liquid hydrogen, placed in the proton beam of the Chicago synchrocyclotron, has been instrumental in obtaining π-mesons from proton–proton collisions up to 220 MeV. Both Dr. Anderson and Mrs. L. W. Marshall reported on work done with meson beams. Cross-sections were determined for the processes:

$$\pi^+ + p \rightarrow \pi^+ + p,$$
$$\pi^- + p \rightarrow \pi^0 + n,$$
$$\text{and } \pi^- + p \rightarrow \pi^- + p.$$

Comparison between these cross-sections was possible at 135 MeV. The elastic scattering was found to be about isotropic, while the charge exchange leads to a marked backward scattering. The cross-section of the first process has been found to be several times larger than that of the last. The observed values agree well with a charge-symmetric interaction which makes the total isotopic spin an integral of motion.

Prof. Kerst's large betatron gives photoproduction of π-mesons, a subject which is under investigation. A search has been made to detect V-particles, so far without result; there is certainly less than one V-particle per 2,500 photomesons at 300 MeV. The difficulties of meson theory were emphasized by J. Leite Lopes (Centro Brasileiro de Pesquisas Físicas), who reported on an attempt made by himself and R. P. Feynmann with the aim of accounting for the deuteron structure by means of pseudoscalar mesons. An interesting point was brought forward by G. Fialho (Centro Brasileiro de Pesquisas Físicas), who, following the suggestion of Prof. G. Tiomno, showed that the, eventually anomalous, magnetic moment of the μ-meson accounts for most of the weak γ-radiation which accompanies the $\pi \rightarrow \mu$ decay.

Finally, high-energy phenomena, in particular the multiple production of mesons, were discussed in two papers. G. Molière (Centro Brasileiro de Pesquisas Físicas) reported on work he had done in Göttingen together with J. Budini—a phenomenological theory of the development of a nucleon cascade. G. Wataghin (University of Turin), outlining what has grown out of the pioneering work he had done during fifteen years in São Paulo, discussed a field theory with non-localized interaction, which promises to account for multiple meson production.

It is perhaps surprising that no new meson was reported during the symposium, though almost a month had passed since a previous meeting of nuclear physicists in Copenhagen.

Among the many other interesting papers, mention must be made of a report by Dr. D. Bohm (University of São Paulo) on his attempt to give a causal interpretation to the formalism of quantum mechanics.

The symposium was judged by all concerned to have been very successful, and not the least credit for this is due to Dr. A. Moses, president of the Brazilian Academy, and to Prof. J. Leite Lopes, who devoted several months to the work of organizing it.

EXPERIMENTS ON THE USE OF DDT, BHC AND DIELDRIN AGAINST ADULT MOSQUITOES AT TAVETA, KENYA

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DURING the past two years, simple mud-walled, thatch-roofed huts fitted with exit window traps and occupied by volunteer Africans have been sprayed with various formulations of the three insecticides, DDT, BHC and dieldrin, and the effect on the *Anopheles gambiæ*, *A. funestus* and culicine mosquitoes entering them observed. Daily mortalities among the mosquitoes were determined by counting the dead individuals on the floors of the huts, and counting those dying later (within 12 hr. of capture) which were caught alive inside the huts in the morning and in the window traps during the night.

In these huts, before any insecticide was applied, it was found that most of the female *A. gambiæ* and *A. funestus*, which entered during the night to feed on the occupants, rested inside the huts after feeding until their blood was digested and their ovaries matured. The gravid mosquitoes then left the hut in the evening. Except during the season of peak production of these species, more mosquitoes left the huts in the evening than during the rest of the night. Nearly all those leaving during the rest of the night and early morning were unfed individuals; very few were fed and showing ovarian development.

In the first series of experiments, an attempt was made to repeat the observations made by Muirhead Thomson[1] in similar huts in Tanganyika. This author, using the DDT wettable powder 'Ditrene', at an estimated dosage of 400 mgm. DDT per square foot, and the BHC wettable powder 'P.530', at 200 mgm. BHC per square foot (26 mgm. of the gamma isomer), concluded that DDT applied to the internal surfaces of a hut only irritated resting *A. gambiæ* and *A. funestus*, causing them to leave the huts without actually killing them. BHC, on the other hand, proved a most efficient residual insecticide and, during the period of his observations (up to thirteen weeks after spraying), no mosquitoes were observed to escape its killing action.

In these experiments, where the insecticide dosages were chemically estimated at 98 mgm. DDT per square foot for 'Ditrene' and 153 mgm. BHC (20 mgm. of the gamma isomer) per square foot for 'P.530', the almost complete absence of kill with 'Ditrene', recorded by Muirhead Thomson[1], was not confirmed, even with the much lower dosage employed. The overall mortality among female *A. gambiæ* and *A. funestus* in the 'Ditrene'-treated hut was 40 per cent in the first month after treatment, falling to approximately 20 per cent in the following two months. The results did show, however, that a large proportion of the mosquitoes escaped the action of this insecticide. In the hut treated with BHC, the mortalities in the first three months were much higher, namely, 99 per cent, 95 per cent and 60 per cent respectively.

Later experiments, using other formulations of DDT and BHC, confirmed these findings. In all the huts treated with DDT, a significant proportion of the female *A. gambiæ* and *A. funestus* entering them escaped unharmed, even immediately after treatment. This proportion was always more than 20 per cent, but never as high as in the hut treated with 'Ditrene'. The DDT formulations and their chemically estimated dosages used in these later experiments are shown in Table 1.

TABLE 1

Formulation	Dosage (in mgm. DDT per sq. ft.)
Suspension of crystals, 0–30 microns	124
Suspension of crystals, 30–70 microns	51
'Murphy Paste'	238
'Murphy Wettable Powder'	229

For six months after treatments with these DDT preparations, the overall mortalities among female *A. gambiæ* and *A. funestus* remained, for the most part, between 50 and 70 per cent, and even in the seventh to ninth months, between 40 and 60 per cent.

The suspension of smaller crystals produced higher kills in the first two months after treatment than did that of larger crystals, confirming the laboratory findings of Hadaway and Barlow[2]. The relatively poor kill produced by the 'Ditrene' in the first series of experiments is accounted for by the fact that this preparation contains a high proportion of large DDT crystals of the order of 80 microns.

The marked irritant properties of DDT were indicated by the fact that the majority of the mosquitoes were caught leaving the huts treated with DDT during the night and early morning, that is, in the window traps, and many of these were freshly blooded individuals. The proportions found dead on the floors of these huts were relatively small.

Two huts treated with BHC—the wettable powder 'P.520'—at 21 mgm. of the gamma isomer per square foot, and the oil-bound suspension 'Supona B' (TP.725), at 18 mgm. of the gamma isomer per square foot, produced similar results. In the first month after treatment, no female *A. gambiæ* and *A. funestus* escaped the effect of these preparations. In the second and third months the overall mortalities among these two species fell from about 90 to 70 per cent, and in the fourth to sixth months from 50 to 30 per cent. In these huts treated with BHC, in the first four months after treatment a higher proportion of the mosquitoes were found dead inside the huts and a lower proportion in the window traps than occurred in huts treated with DDT.

A hut treated with a mixture of BHC and DDT in an oil-bound suspension (TP.726) at calculated dosages of 54 mgm. BHC (7 mgm. of the gamma isomer) and 223 mgm. DDT per square foot, showed the high initial kill of BHC (94 and 88 per cent overall mortalities among female *A. gambiæ* and *A. funestus* in the first two months after treatment) and the moderately high, long-lasting kill of DDT (76, 63, 82 and 59 per cent in months three to six). The irritant effect of DDT was again indicated by the high proportion of the mosquitoes collected from the window traps.

In the later experiments a hut was also treated with the new insecticide, dieldrin. This was applied in the form of a wettable powder at a calculated dosage of 50 mgm. dieldrin per square foot (chemical estimations yielded the very low average figure of 7·2 mgm. of dieldrin per square foot, but this was entirely incompatible with the calculated dosage). Results showed this insecticide to be the most efficient of those tested. For three months after treatment, mortalities among female *A. gambiæ* and *A. funestus* were 100 per cent, and in the following six

months they remained greater than 80 per cent. For the greater part of this period the majority of the mosquitoes collected were found dead inside the hut.

Little difference in the effects of the insecticides on *A. gambiæ* and *A. funestus* females was observed. Against *Culex fatigans* all the DDT preparations gave very low kills (10–30 per cent), the BHC ones high initial kills (85 per cent in the first month, 7–30 per cent in months two to six) and dieldrin high, long-lasting kills (between 60 and 95 per cent for seven months after treatment).

In the later series of observations, *A. gambiæ* and *A. funestus* females, caught from untreated houses in the area, were suspended in cages inside the huts without actual contact with the treated surfaces. After varying lengths of time the cages were removed and the mortalities among the mosquitoes determined 24 hr. later. The BHC preparations (P.520 and the oil-bound suspension) produced high kills among mosquitoes suspended for two to twelve hours for three months after treatment, especially among those nearest the treated surface. In two huts treated with DDT (the two Murphy formulations) the kills varied considerably but were generally low, even when the mosquitoes were left overnight (12 hr.). On the other hand, dieldrin produced very high kills among these suspended mosquitoes throughout the nine months observations.

DDT and dieldrin are both relatively non-volatile insecticides, and these kills among mosquitoes suspended without actual contact are probably due to the presence of airborne particles of the insecticides in the huts. If these particles occurred in similar numbers in both the huts treated with DDT and those treated with dieldrin, higher kills would be expected in those treated with dieldrin because of the greater toxicity of this insecticide.

Kills in the huts treated with BHC, where the insecticide is a volatile one, are probably due to a combination of fumigant and particulate effects.

In conjunction with these hut experiments, observations were also made on the resting times of individual mosquitoes on cardboard surfaces treated with the various insecticides. With all three insecticides, *A. gambiæ* and *A. funestus* females were irritated by contact and after varying periods left the treated surface and flew towards light. These irritated mosquitoes were then caught and kept for 24 hr. and the mortality among them recorded. It was clearly demonstrated that a high proportion of these specimens were irritated and left a surface treated with DDT before they acquired a lethal dose of the insecticide. The longest contacts and the highest kills occurred with dieldrin, and slightly lower figures were recorded for BHC. With the mixture of BHC and DDT, a short contact occurred as with DDT alone, but a higher mortality was produced than with DDT alone. Table 2 summarizes the results obtained with surfaces treated with various formulations of the three insecticides in varying dosages up to two weeks after treatments.

TABLE 2

Insecticide	Total mosquitoes tested	Average contact time (min.)	Percentage mortality after 24 hr.
	A. gambiæ		
BHC	51	22	75
DDT	71	8	32
BHC and DDT	7	8	57
Dieldrin	30	28	97
	A. funestus		
BHC	61	27	82
DDT	87	10	51
BHC and DDT	6	7	67
Dieldrin	17	36	94

A detailed account of these experiments, which were carried out on behalf of the Colonial Insecticides Committee, Colonial Office, London, is to be published shortly. [April 23.

[1] Muirhead-Thomson, R. C. *Trans. Roy. Soc. Trop. Med. and Hyg.*, **43**, 401 (1950).
[2] Hadaway, A. B., and Barlow, F., *Bull. Ent. Res.*, **41**, 603 (1951).

'DOUBLE FRONTING' IN PAPER CHROMATOGRAPHY OF PROTEINS

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DURING the first half of the present year, several authors have reported separations of proteins and enzymes by paper chromatography[1]. However, no investigations concerning the mechanism of this chromatographic process have as yet been published.

In this communication a few simple experiments are described which seem to indicate that there is a sort of 'double fronting' which appears to be the result of a displacing effect, and which has a great influence on the movement of the protein. Recently, E. Lester Smith[2] and also T. C. J. Ovenston[3] pointed out the possibilities of getting double zoning in partition chromatography. In spite of the analogy, it seems difficult to judge at present if the mechanisms in the two cases are similar.

The experimental procedure has been as follows. On a paper strip 12 cm. × 20 cm. (Whatman 54), six spots of commercial human serum albumin are placed on a line drawn obliquely across the paper (see Figs. 1–3). The chromatogram is then developed (temp. + 4° C.) with a mixture of 30 per cent ethanol and 70 per cent phosphate buffer ($\mu = 0{\cdot}10$), *p*H 7·7, and after the run the protein spots are made visible by staining with bromphenol blue[4]. Instead of falling on an oblique line as at the start, all the spots appear at the same distance from the front of the developing liquid (Fig. 1*b*). If the run is stopped at an earlier stage, the appearance of the chromatogram is somewhat different (Fig. 1*a*).

It is, however, also possible to apply the serum albumin behind the solvent front in the following way. The paper (without protein) is developed until

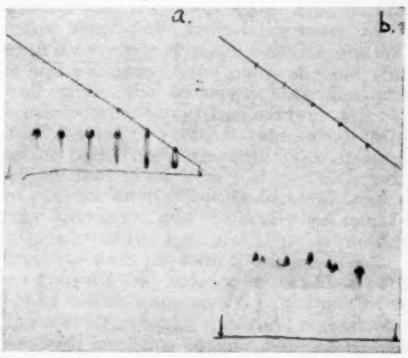

Fig. 1. Serum albumin placed on an oblique starting line and developed with ethanol and buffer (30 : 70)

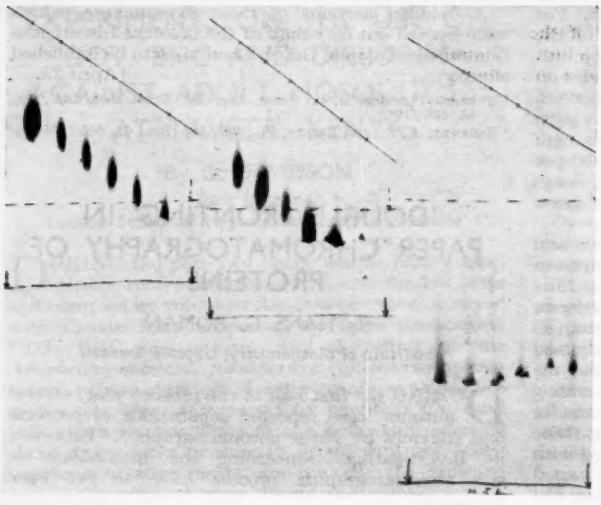

Fig. 2. Chromatograms with the albumin applied behind the solvent front

the solvent front has passed about 4 cm. beyond the last mark on the oblique starting line (that is, reached the dotted line in Fig. 2). The paper is then quickly taken out and serum albumin is applied to the starting marks by means of a capillary pipette. Development is then continued. Fig. 2 shows three such experiments which have been stopped at different times.

Two things may be specially noted. First, in the early stage of the process the spots occur obliquely, as is to be expected in ordinary chromatography, and have the usual oval shape. This gradually changes as if the spots were taken up by 'an invisible front' behind, but parallel to, the front of the developer. At the same time as the spots reach this 'front', they change to a more compressed shape. Secondly, all the oval spots are moving faster (R_F 1·2) than the front of the developing liquid, which means that part of the developer is adsorbed by the paper. This is in agreement with the results of Kowkabany and Cassidy[5].

Further, if, before the run, the paper is exposed to the atmosphere in the chromatographic vessel for at least eight hours, the adsorption of the albumin is decreased to such an extent that it follows the front of the developing liquid. In this way it is also possible for the albumin to pass the 'invisible front'. The rate of travel of this second front seems fairly constant; the R_F value as measured from the end of the paper is about 0·8.

These experiments can be explained as follows. Fig. 1*a* shows that at first the albumin travels closely behind the front, but that it is partly adsorbed on the paper. After a time, all the albumin has been adsorbed and the appearance of the chromatogram should be a series of narrow fingers of the same length (compare Fig. 3*a*). When, however, the developer travels through the paper, it causes some changes in it, possibly in the charge, which almost completely prevent serum albumin from being adsorbed behind this 'displacing front'. Thus the spots are taken up one by one by this front during the run. The shape of the spots also depends on the fact that the albumin is adsorbed before, but not after, this front. According to this view, the same changes in the paper should take place when it is exposed to the vapour.

In an early stage, when only some of the protein has been adsorbed and the 'displacing front' has passed the starting point, it is possible to get two spots (see Fig. 3*d*). In this way one can consequently split a homogeneous substance into two components —an artefact that may be of some interest.

As both serum albumin and the paper at *p*H 7·7 are negatively charged, *p*H changes towards the isoelectric point would be expected to cause increasing adsorption. Fig. 3 shows four chromatograms developed with the same concentration of ethanol (30 per cent) but with different phosphate buffers ($\mu = 0{\cdot}10$): (*a*) *p*H 5·2, (*b*) 6·0, (*c*) 6·9 and (*d*) 7·7. It is easy to follow the decreasing effect of the 'displacing front' the more strongly the albumin is adsorbed.

Preliminary experiments have given the same result for another paper (Whatman 1) and for phycoerythrin using acetone buffer as the developing agent.

The phenomena described here indicate that great care must be exercised in the interpretation of the results obtained by filter-paper chromatography of proteins.

I wish to express my thanks to Prof. A. Tiselius for his interest and advice. [June 20.

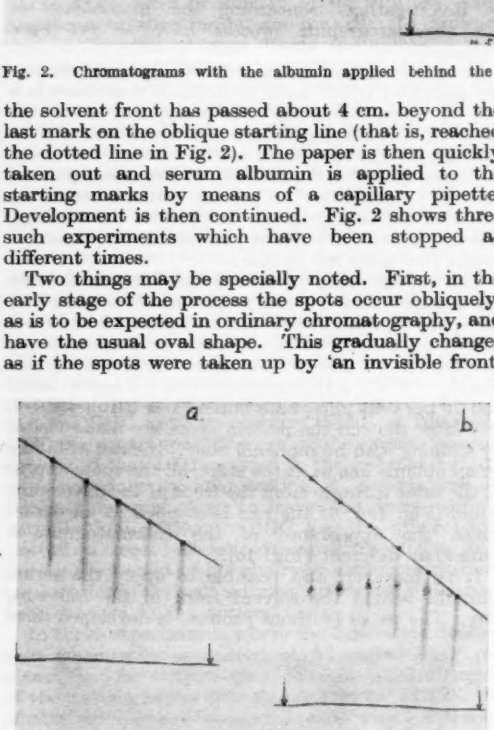

Fig. 3. Chromatograms developed with 30 per cent ethanol and different phosphate buffers, *p*H being (*a*) 5·2, (*b*) 6·0, (*c*) 6·9 and (*d*) 7·7

[1] Gillespie, J. M., Jermyn, M. A., and Woods, E. F., *Nature*, **169**, 487 (1952). Jermyn, M. A., *Nature*, **169**, 488 (1952). Girl, K. V., *et al.*, *Biochem. J.*, **51**, 123 (1952). Cabib, E., *Biochim. Biophys. Acta*, **8**, 607 (1952).
[2] Smith, E. L., *Nature*, **169**, 60 (1952).
[3] Ovenston, T. C. J., *Nature*, **169**, 924 (1952).
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[5] Kowkabany, G. N., and Cassidy, H. G., *Anal. Chem.*, **24**, 643 (1952).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Relativistic Theory of a Rigid Body

GARDNER[1] has recently given a new relativistic theory of a rigid body, and Synge[2] has applied this theory to the earth considered as a rigid body in rotation. He predicts, on the basis of the Gardner theory, that the fringes in a Michelson interferometer with one arm inclined at 45° to the horizontal should shift on rotating the interferometer about a vertical axis—provided that the interferometer is rigidly attached to the earth. The fringe shift predicted is $\left(\frac{E}{c}\frac{D}{\lambda}\right)\sin\theta$, where E is the velocity of earth's rotation, D is the length of the arm of the interferometer and θ is the angle between the projection of the direction of the inclined arm on a horizontal plane and a line pointing north[3].

We have made the following experiment to look for the predicted shift. A Michelson interferometer (made by Messrs. Hilger–Watts) was modified: (*a*) by mounting it on a suitable stand so that the arm along which the light enters is horizontal and the other arm is tilted so that the observer looks downwards along a line at 45° to the horizontal; (*b*) by clamping the movable carriage to the bed of the interferometer to give an arm of fixed length (approximately 12 cm.); (*c*) by extending the other arm to about the same length. The apparatus was clamped to the table of a large drilling machine. This table could be unclamped for rotation or clamped to the base of the drilling machine. The floor was of bituminous material, into which the feet of the machine were embedded. Underneath this was a concrete raft resting on earth.

The 5461-A. line of mercury obtained from a low-pressure source mounted on the drilling table was used. The instrument was adjusted to give about three straight-line fringes in the field of view. They could be regarded as localized on the mirror opposite the observer, who looked in through a pinhole. A line drawn in the silvering of the mirror was used as a reference mark.

The interferometer was arranged so that the observer looked along a line pointing westwards (and downwards). The position of the fringes was observed (1) with the table clamped and (2) with it unclamped. The table was then slowly rotated by hand, the observer viewing the fringes during rotation. When the table had been rotated through 90° so that the observer looked in a northerly direction, the rotation was stopped and the position of the fringes noted with the table clamped and with it unclamped. The table was then rotated through a further 90°, and the position of the fringes was again observed with the table clamped and with it unclamped.

The following results were obtained: (1) no significant change in the position of the fringes was obtained on clamping or unclamping the table, (2) during rotation the fringes vibrated with an amplitude of about 0·1 fringe, but on stopping the rotation they came to rest in the original position. In the best tests, a shift of 0·05 fringe should have been observable and no shift was observed. The shift calculated from the above formula is 0·42 fringe, and since 0·1 fringe could easily have been detected we conclude that the predicted shift does not take place.

We wish to thank Prof. J. L. Synge for a private communication in which he discussed the conditions to be fulfilled in testing the theory.

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Physics Department,
University of Reading. Sept. 8.

[1] Gardner, G. H. F., *Nature*, **170**, 243 (1952).
[2] Synge, J. L., *Nature*, **170**, 243 (1952) *Sci. Proc. Roy. Dublin Soc.* **26**, 45 (1952).
[3] Synge, J. L. (private communication).

Permafrost Drilling and Soil-Temperature Measurements at Resolute, Cornwallis Island, Canada

IN August 1948, a drilling programme was carried out at Resolute, N.W.T., Canada, lat. 74° 41′ N., long. 94° 54′ W., to locate a suitable site for a future seismological station. When this had been completed, a series of shallow holes was drilled about 100 ft. north of the weather station operations building, and ceramic resistance thermometers were inserted at depths of 8, 18, 39 and 60 in.

In 1950 it was decided to extend the scope of this investigation and attempt to obtain information from much greater depths in the permanently frozen ground. A maximum depth of 1,000 ft. was set as the objective. This project was made possible by the joint efforts of the Meteorological Division of the Canadian Department of Transport, the United States Weather Bureau, and the Dominion Observatory of Ottawa, Canada.

To begin each hole, a 2½-in. pipe was driven to bedrock with a 350-lb. hammer. It was found in each case that the overburden was approximately 6 ft. thick and consisted of frozen gravel. The bedrock was limestone with occasional faults and cracks. The drill hole had a diameter of 1⅛ in. and recovered core with diameter 15/16 of an inch.

Holes were drilled to depths of 6, 11, 23, 30, 50 and 103 ft. and cables with temperature elements were inserted in each. All the core was recovered from the 103-ft. hole. The most serious problem encountered was the maintenance of an adequate circulation of hot water in the drill hole to prevent frost formation.

An improved hot-water boiler and pumping equipment were provided in 1951 and a further attempt was made to drill to a depth of 1,000 ft. Water for the drilling was obtained by pumping it directly from a lake 1,500 ft. distant, and drilling operations were carried on around the clock. As the drilling proceeded to greater depths, the circulating water had to be heated to a correspondingly higher temperature. The valves and plungers of the pump did not stand up too well under the increased heat and pressure, and breakdowns occurred frequently.

Out of a total of seven holes which were drilled during the period from the first week of July until August 20, five holes were lost. Three were lost due to cave-in, another owing to breakdown of the pumping equipment, and the fifth when mud formed at the bottom of the hole and the line pressure was insufficient to wash the mud to the surface.

The remaining two holes were drilled to depths of 307 ft. and 453 ft. respectively. Thermistor elements were lowered into each of these and regular temperature readings are being taken. The 453-ft. hole was completed in four days. A greater depth could have been reached; but so much drilling equipment had

been lost in the other holes that no drill rods were available to progress farther. A continuation of the permafrost drilling programme is being carried out during the present summer, when it is hoped that the objective of 1,000 ft. will be reached.

The average conductivity of the bedrock as determined from the core samples by Prof. A. D. Misener, of the University of Western Ontario, London, Ontario, is :

$$K = 0{\cdot}0066 \text{ c.g.s. units at } 31{\cdot}2^\circ \text{ C.}$$

A thorough analysis has not been made as yet of the soil temperature observations from Resolute. Nevertheless, a number of interesting features has been noted.

(1) The temperatures at the 8-in. level show short-period fluctuations which reflect the fluctuations of the air temperature above the surface. However, these fluctuations from ambient air temperatures are rapidly damped out with increasing depth and are practically negligible at the 60-in. level.

(2) There is a marked lag in seasonal temperature changes with depth. For example, the temperatures at the 8-in. and 18-in. levels reach a maximum about the second week in August, whereas the temperature at the 60-in. level continues to rise until mid-September. The temperatures from the surface to the 60-in. level fall at varying rates after mid-September, so that by the last week in September there is a reversal in sign of the temperature gradient.

(3) The temperatures in the layers near the surface begin to rise in early March, and about May 1 there is again a reversal in sign of the temperature gradient from the surface to the 60-in. level.

(4) From about August 25 to September 15, the temperatures within 18 in. of the surface remain near the freezing point, indicating that the complete freezing of the water in the active layer takes about three weeks.

(5) The temperatures at the 98-ft., 300-ft. and 450-ft. levels remain practically constant with the following values : 98 ft., $-13{\cdot}50^\circ$ C. ; 300 ft., $-11{\cdot}59^\circ$ C. ; 450 ft., $-9{\cdot}54^\circ$ C.

(6) The layer from 50 ft. to 98 ft. is nearly isothermal.

(7) Seasonal temperature changes are perceptible to near the 50-ft. level ; but the lag at this level amounts to about six months.

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Reaction between Diethyl Peroxide and Nitric Oxide

In the hope of trapping the radicals probably produced during the photolysis of diethyl peroxide, the vapour of the latter was mixed with a several-fold excess of nitric oxide in a 3-litre 'Pyrex' bulb. The mixture was then passed through a water-cooled helical silica tube surrounding a mercury arc into a trap immersed in 'Drikold'. Suspiciously large amounts of ethyl nitrite were found in the trap, and even larger quantities were collected in a blank run without the arc. After the mixture had been stored in the dark for twenty-four hours, spectrophotometric examination showed that a major portion of the peroxide had been converted into nitrite.

The inhibition by nitric oxide of the thermal decomposition of diethyl peroxide[1] is clearly no evidence for a free radical mechanism.

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April 23.

[1] Moriya, *Rev. Phys. Chem., Japan*, 143 (1946).

Inhibition of the Thermal Decomposition of Diethyl Peroxide

The mechanism of the thermolysis of diethyl peroxide is uncertain. Harris and Egerton believed the reaction to be a straightforward, unimolecular decomposition, although they observed short induction periods with some samples and generally much longer ones in the presence of nitric oxide[1]. The products suggest the occurrence of reactions involving free radicals, and in the opinion of Neumann[2] the decomposition is a chain reaction. It is, however, difficult to reconcile a significant participation of free radicals in the decomposition with the first-order kinetics and the low activation energy (*c.* 31 k.cal.), compared with accepted dissociation energies of O—O bonds (HO—OH, 54 k.cal.[3], *t*.BuO—O*t*.Bu, 39 k.cal.[4]).

A re-examination of the reaction in a spherical 2-litre 'Pyrex' vessel using peroxide pressures of a few millimetres of mercury has, in the main, confirmed the results obtained by Harris and Egerton. Our velocity constants, derived from initial rates, were however about 25 per cent greater than those of Harris and Egerton, and the activation energy a little smaller. An appreciable reaction of zero order appeared to be superimposed on the first-order reaction at temperatures below 160° C. During the course of individual reactions, the first-order law was not well obeyed by the pressure change, and the energy of activation derived from the 'half lives' of the pressure change were considerably less than that obtained from the initial rates, and was, indeed, close to the value of about 22 k.cal. obtained by Russian authors[2].

When hydrogen iodide was added to the peroxide vapour at *c.* 140° C., the rate of change of pressure was reduced and iodine was formed. Excess hydrogen iodide reduced the rate to zero. Addition of iodine also inhibited the pressure change, although not completely, a limit of about 40 per cent of the uninhibited rate being attained with excess iodine.

In view of the reaction observed with nitric oxide[5], caution is required in the interpretation of these observations, which are being extended.

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April 23.

[1] *Proc. Roy. Soc.*, A, **168**, 1 (1938).
[2] Blat, Gerber and Neumann, *Acta Physicochim., U.R.S.S.*, **10**, 273 (1939). Neumann and Tutakin, *Acta Physicochim., U.R.S.S.*, **9** 861 (1938).
[3] Giguere, *Canad. J. Res.*, B, **28**, 17 (1950).
[4] Rust, Seubold and Vaughan, *J. Amer. Chem. Soc.*, **72**, 338 (1950).
[5] Mortlock and Style (see preceding communication).

A New Method of Melting Ferromagnetic Semiconductors. $BaFe_{18}O_{27}$, a New Kind of Ferromagnetic Crystal with High Crystal Anisotropy

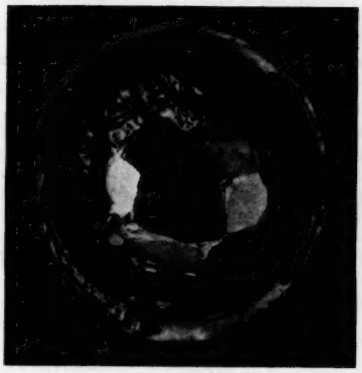
In recent years, ferromagnetic oxides have become of great interest for electrotechnical applications[1,2]. They are used in the form of polycrystalline sintered materials. In order to get a better insight into the properties of the material itself, without the additional influence of air pores, we started to prepare these oxides from the melt. Moreover, we hoped to grow from these melts single crystals large enough for magnetic measurements.

Smiltens *et al.*[3] melted magnetite, Fe_3O_4, in an electric furnace at about 1,600° C. By moving the platinum crucible through a temperature gradient, large single crystals were obtained. Galt *et al.*[4,5] grew small single crystals of nickel ferrite and manganese zinc ferrite from a borax melt.

We have applied the high-frequency melting technique common in research on metals. Special problems arise in using this high-frequency technique when dealing with oxides, which are mostly semiconductors with a high resistivity at room temperature. All ferromagnetic materials investigated were composed of several oxides, one of which was always iron oxide. As magnetite is an iron oxide with a relatively low resistivity ($\rho = 0{\cdot}01$ ohm cm. at room temperature[6]) it has been used as a starting material for the melts, instead of α-Fe_2O_3.

In order to prevent oxidation of the material and the resultant loss of conductivity during heating, the melting process is carried out in a nitrogen atmosphere containing less than 10^{-4} parts of oxygen. Sintered magnetite disks are placed in a quantity of a metal oxide powder such that the desired ratio of the metal ions in the final product is obtained. When the contents of the crucible have completely melted in the nitrogen atmosphere, this atmosphere is gradually changed to the equilibrium oxygen atmosphere of the ferromagnetic oxide at its melting point. The conductivity of the ferromagnetic oxides in the neighbourhood of this temperature is sufficiently high to make the high-frequency induction currents keep these oxides in the molten state. An advantage of this method of melting is the possibility of inserting the high-frequency coil in a high-pressure apparatus, so that when the contents of the crucible have melted in a reducing atmosphere, the nitrogen can be replaced by oxygen at a pressure much higher than atmospheric. Another advantage is that it is not the crucible itself that is directly heated, but its contents; thus the crucible has a slightly lower temperature than is the case when using the electric furnace technique, and thus contamination of the melt by the crucible material will be slower. Several kinds of crucibles have been used, the best results being obtained with one of alumina preheated to a temperature slightly below its melting point. The top of the melt was kept at the same or even at a higher temperature than the bottom by putting a disk of rhodium or iridium metal as a lid upon the crucible. In the high-frequency field, this metallic disk attains a higher temperature than that of the contents of the crucible, thus causing additional heating of the surface.

Disk-shaped surface crystals grow when the melting process described above is followed by a reduction of the high-frequency current and consequent slow cooling below the temperature at which the contents solidify. The accompanying illustration is a photograph of the surface of the contents of the crucible, showing several crystals of manganese ferrite (diameter of the crucible 32 mm.). One of these materials has a [100] plane parallel to the surface, while all other planes shown are [111] planes.



Surface of the contents of a crucible showing several disk-shaped single crystals of manganese ferrite (crucible diameter, 32 mm.)

Magnetite crystals containing less than 2 per cent ferrous ions in excess are obtained from the melt if the melting process is carried out in an atmosphere having less than about 10^{-4} atm. oxygen pressure. In order to prevent oxidation during cooling, the melt is rapidly cooled (within 10 min.) from just below the melting point (1,600° C.) to about 1,000° C., after which it is cooled to room temperature in about five hours. The equilibrium oxygen pressure at the melting point appeared to differ greatly from that given by Darken and Gurry[7] (about 0·06 atm. oxygen), but is in good agreement with the figure given by Smiltens[3]. The equilibrium atmosphere of manganese ferrite at its melting point (1,600° C.) appeared to be about 1 atm. of oxygen (crystals containing 0·17 per cent ferrous ions by weight were obtained), which was also found recently by Gurry and Darken[8].

Another interesting ferromagnetic material is $BaFe_{12}O_{19}$, which has a hexagonal structure[2] and shows a very high magnetic crystal anisotropy. Experiments on the melting of magnetite with different amounts of barium carbonate gave three kinds of hexagonal phases with different *c*-axes, respectively 23·2, 32·8 and 28 A. Mostly these phases formed thin alternating layers of parallel-oriented crystals, and a single type of crystal could not be separated. Braun (see ref. 2) found that the first kind has the magnetoplumbite structure already described by Adelsköld[9]. From a melt of 12 gm. Fe_2O_4 and 1·8 gm. $BaCO_3$ in oxygen, a single crystal with a *c*-axis of 32·8 A. was separated. The dimensions of this crystal were $4 \times 5 \times 0{\cdot}3$ mm. An account of the X-ray examination of this crystal is given by Braun[10]. This crystal proved to have the composition $BaFe_{18}O_{27}$ and a structure resembling that of $BaFe_{12}O_{19}$. It has the hexagonal axis perpendicular to the surface of the disk, and in a homogeneous magnetic field this *c*-axis becomes oriented parallel to the lines of force, which suggests a very strong crystal anisotropy. Results of magnetic measurements are given elsewhere[2].

I wish to thank Dr. J. J. Went for his interest and advice during the experiments.

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June 12.

[1] See, for example, Snoek, J. L., "New Developments in Ferromagnetic Materials" (Elsevier, 1947).
[2] Went, J. J., Rathenau, G. W., Gorter, E. W., and van Oosterhout, G. W., *Philips Tech. Rev.*, **14**, 33 (1952).
[3] Smiltens, J., and Fryklund, D. H., Progress Report V, Mass Inst. Tech., p. 58 (1949).
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[8] Gurry, R. W., and Darken, L. S., *J. Amer. Chem. Soc.*, **72**, 3906 (1950).
[9] Adelsköld, V., *Ark. Kemi, Mineral. Geol.*, **12A**, 1 (1938).
[10] Braun, P. B., see following communication.

Crystal Structure of $BaFe_{18}O_{27}$

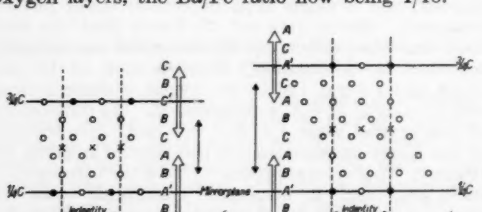
In the course of an investigation[1] into the properties of substances with magnetoplumbite structure[2], Wijn[3] of these laboratories tried to prepare single crystals of $BaO.6Fe_2O_3$. Mixtures of barium oxide and magnetite (Fe_3O_4) were melted and slowly cooled. In one of these melts a single crystal of about $4 \times 5 \times 0{\cdot}3$ mm.^{3} developed.

The results of the X-ray investigation of this crystal are shown below. The notation used is that of the "International Tables for the Determination of Crystal Structures" (1935).

Composition, $BaFe_{18}O_{27}$ $a = 5{\cdot}88$ A. $c = 32{\cdot}84$ A.		Space group $C6/mmc$ 2 formula units per cell	
2 Ba on	$2(b)$		
2 Fe ,,	$2(d)$		
4 Fe ,,	$4(f)$ $z = 75°$		
4 Fe ,,	$4(e)$ $z = \overline{20}°$		
4 Fe ,,	$4(f)$ $z = \overline{26}{\cdot}8°$		
4 Fe ,,	$4(f)$ $z = 33{\cdot}5°$		
6 Fe ,,	$6(g)$		
12 Fe ,,	$12(k)$ $z \sim \overline{54}°$ $x \sim 60°$		
		$\bar{6}$ 0 in $6(h)$	$x \sim 180°$
		12 0 ,, $12(k)$ $z = \overline{64}{\cdot}5°$	$x \sim 60°$
		4 0 ,, $4(f)$ $z = \overline{64}{\cdot}5°$	
		12 0 ,, $12(k)$ $z = 40°$	$x \sim 180°$
		4 0 ,, $4(e)$ $z = 40°$	
		12 0 ,, $12(h)$ $z = \overline{13}°$	$x \sim 60°$
		4 0 ,, $4(f)$ $z = 13°$	

The magnetoplumbite structure can be described as consisting of spinel-like blocks, with the thickness of four oxygen layers, linked together by layers in which one oxygen has been replaced by barium. The linking layer is hexagonally packed with respect to its neighbouring layers. Moreover, it contains an iron atom surrounded by five oxygen atoms in a trigonal dipyramid.

The new structure described here is built along the same lines. The spinel block has not four but six oxygen layers, the Ba/Fe ratio now being 1/18.



$BaFe_{18}O_{27}$ Two formula units per cell — $BaFe_{18}O_{27}(16Fe^{3+},2Fe^{2+})$ Two formula units per cell

⟺ Hexagonal close-packed layers

◀—▶ Cubic close-packed layers

○, Oxygen; ●, barium; ×, centre of symmetry.

A detailed discussion of the structure determination will be published elsewhere.

The accompanying drawings show the relation between the two structures mentioned. They represent sections through the 0001 and $11\bar{2}0$ axes. All iron atoms are omitted; they are distributed regularly among the cavities in the close packing of oxygen and barium.

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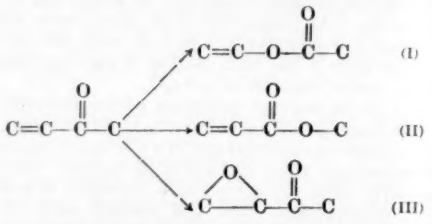
[1] Went, J. J., Rathenau, G. W., Gorter, E. W., and van Oosterhout, G. W., *Philips Tech. Rev.*, B, **194** (1951–52); *Phys. Rev.*, **86**, No. 3, 424 (1952).
[2] Adelsköld, V., *Ark. Kemi, Mineral. Geol.*, **12A**, No. 29 (1938).
[3] Wijn, H. P. J., see preceding communication.

Peroxidation of Unsaturated Ketones

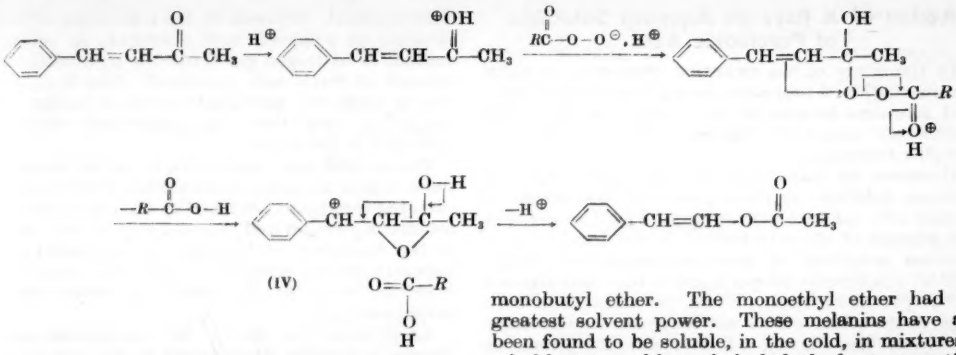
Two recent reviews of peroxidation of organic compounds[1,2] cite the fact that α,β-unsaturated ketones are oxidized by peracids to enol esters. *A priori*, however, one might expect one or more of three possible products and their hydrolysates.



Thus, I and II would result from an attack of peracid at the carbonyl carbon followed by rearrangement according to the mechanism proposed by Criegee[3], Friess[4], and Doering[5], while III would be the consequence of an attack at the β-carbon of the conjugated system.

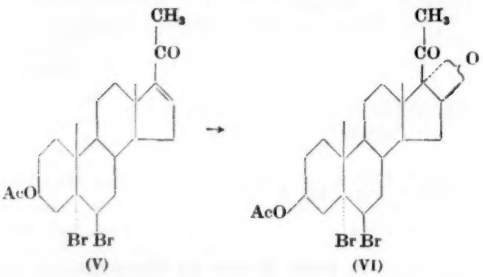
With the exception of a few peroxidation reactions in the terpene field, only three main examples[6–8] of this process appear in the literature, and in all three cases the starting compounds possess a phenyl group in the β-position. On applying the accepted mechanism[3–5] to this system (for example, benzalacetone), it becomes apparent that the transition state involves a mesomeric benzyl carbonium ion (IV) if the electron-rich carbon–carbon double bond is permitted to participate in breaking the peroxide linkage. Since (IV) constitutes a low-energy state, it would be expected that the above transition requires less activation energy than either the migration of the methyl group (to yield II) or an original attack of the peracid molecule on the β-carbon (to yield III). Thus, it might be predicted that any α,β-unsaturated carbonyl system containing a substituent in the β-position, which has the power of stabilizing a carbonium ion there, would yield an enol ester or lactone on peracid oxidation. Furthermore, systems not having this property might be expected to yield the same, and/or α,β-unsaturated esters or lactones and/or α,β-epoxy-ketones.

Julian's perbenzoic acid oxidation[9] of 5,6-dibromo-16-pregnen-3β-ol-20-one acetate (V) to the 16,17-oxido compound (VI) lends some credence to the above argument. Likewise, preliminary experi-



(IV)

ments of an extensive research of the peracid oxidation of unsaturated ketones in these laboratories have yielded similar results; for example, an α-phenyl-α,β-unsaturated ketone reacted with peracetic acid giving a mixture consisting mainly of compounds II and III. It is hoped to report on the outcome of these investigations in due course.



(V) (VI)

Helpful discussions on the above problem with Prof. G. Stork are gratefully acknowledged.

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[2] Criegee, *Fortschr. Chem. Forsch.*, **1**, 508 (1950).
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Solubility of Melanins

IN further attempts to find a solvent for melanin which would be of use in histological work, the following substances have been found to dissolve, in the cold, the pigments extracted from the ink sac of *Sepia officinalis* and melanoma tissue, and those prepared from adrenaline and 3,4-dihydroxyphenylalanine (dopa): ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, and ethylene glycol monobutyl ether. The monoethyl ether had the greatest solvent power. These melanins have also been found to be soluble, in the cold, in mixtures of ethyl lactate and benzyl alcohol, the best proportions being 6 of the former to 4 of the latter (by volume). In all these solvents the solubilities of sepia, melanoma and adrenaline melanins were, so far as could be determined from what must be regarded as impure specimens, of the same order, but the melanin from 3,4-dihydroxyphenylalanine was much less soluble than the others. However, these solvents failed to dissolve the melanin in sections of melanoma tissue, even with the aid of heat. The method used for extracting the sepia and melanoma melanins was: (1) solution in 10 per cent aqueous sodium hydroxide, (2) filtration and precipitation of the melanin by dilute hydrochloric acid, (3) removal of extraneous fatty substances by extraction with ethyl alcohol, chloroform and benzene, (4) repetition of (1) and (2). This extraction procedure was also applied to melanins from 3,4-dihydroxyphenylalanine and adrenaline, but in spite of this uniformity of treatment the former product was still the least soluble of the four types of pigment.

Millott and Jacobson[1] have recently directed attention to the variations in the solubility of melanin as described by different workers in this field. In the case of sepia and melanoma melanins, as compared with that from 3,4-dihydroxyphenylalanine, these differences in solubility may well be due to combination of the pigment with other intracellular substances, probably proteins. (Preliminary experiments have suggested that sepia melanin has a molecule approximately twice the size of that from 3,4-dihydroxyphenylalanine[2].) This does not explain the difference in solubility between 3,4-dihydroxyphenylalanine and adrenaline melanins; but this may be due to the persistence of the methyl group, attached to the indole nitrogen, in the adrenaline product[3].

Two conclusions appeared to be justified: (1) removal of melanin from the ink sac of *Sepia officinalis* and melanoma tissue by the method described above altered its chemical composition; and (2) these melanins, after taking into consideration this effect of extraction, are not identical with that derived from 3,4-dihydroxyphenylalanine.

The work has been carried out with the aid of a grant from the Government Grant Committee of the Royal Society.

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May 5.

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Action of X-Rays on Aqueous Solutions of Perchloric Acid

In the study of the radiation chemistry of metal ions in solution, it may seem desirable to use perchloric acid solutions because it is generally assumed that perchlorate ions show relatively little tendency to complex formation.

However, as was found recently[1], perchlorate in aqueous solutions is decomposed by the action of X-rays into chlorate and oxygen. Fig. 1 shows that the amount of chlorate formed in the irradiation of aqueous solutions of perchloric acid by X-rays (200 kV.) is directly proportional to the concentration of the perchloric acid. While the addition of ceric salts to the solution does not influence the formation of chlorate (see Fig. 1), if ferrous salts are present in the solution, chloride is formed in an amount which is equivalent to the chlorate formed in the absence of ferrous salt, under otherwise similar conditions.

Fig. 2 shows some of the results obtained in the system ferrous perchlorate – perchloric acid. In this case, particularly at the higher perchloric acid concentrations, the results do not show the normal features of the radiation chemistry of the ferrous – ferric system[1]. Whereas in the irradiation of ferrous sulphate in sulphuric acid solutions, *in vacuo*, the amount of hydrogen gas formed is equivalent to the amount of ferric salt produced[1], this is no longer true in perchloric acid solutions where, under similar conditions, less than the equivalent amount of hydrogen is produced.

Fig. 1. Dependence of the formation of chlorate on the concentration of perchloric acid. Irradiation with X-rays (200 kV.) at constant dose of 2×10^5 e.u., in the presence of air. (1 e.u. ≡ 93 ergs/ml.) ○, aqueous perchloric acid; +, aqueous perchloric acid in the presence of ceric perchlorate ($3{\cdot}17 \times 10^{-3}$ *M*)

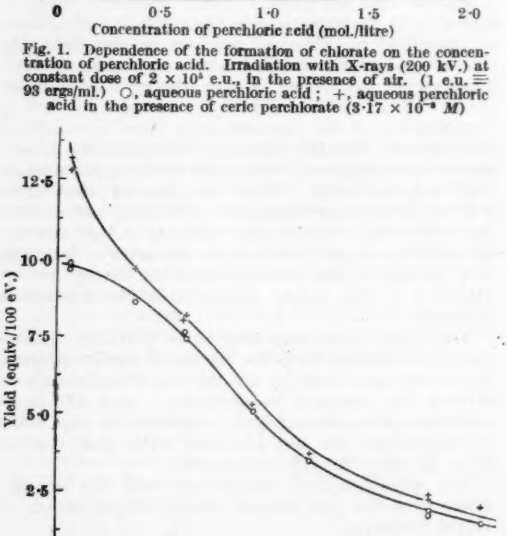

Fig. 2. Dependence of the yield of ferric salt (+) and of hydrogen (○) formed in the irradiation of ferrous perchlorate (0·01 *M*) in evacuated solutions at different concentrations of perchloric acid (as indicated by the *p*H). X-rays (200 kV.); constant dose of about $3{\cdot}70 \times 10^5$ e.u.

The general conclusions which can be drawn from these results are again in agreement with the assumption that the energy absorbed by the water leads to the net decomposition: $H_2O \longrightarrow\!\!\!\!\sim\!\!\!\!\sim\!\!\!\!\rightarrow H + OH$, resulting in the formation of hydrogen atoms and hydroxyl radicals[2], which, however, under the conditions in question, seem to be unable to react with the perchlorate.

As pointed out above, the amount of chlorate formed is directly proportional to the concentration of the perchlorate. This would be in agreement with the assumption that its formation is due to a 'direct' effect, that is, to the radiation energy which is absorbed by the perchlorate itself. It is conceivable that this mechanism involves the formation of an unstable intermediate leading to the formation of chlorate (which is not influenced by ceric salts) and which in the presence of ferrous salts is further reduced to chloride.

A full account will be published elsewhere.

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July 16.

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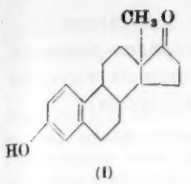
A New Route to Œstrone

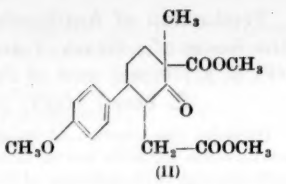
In a recent paper, Johnson and Christiansen[1] have reported a new total synthesis of œstrone (I) from the keto-diester (II).

For a number of years we have been engaged in the study of the Friedel–Craft reaction with the view of preparing compounds of type II. We have already reported[2] the synthesis of 4-methyl-4-carbethoxy-(*p*-methoxyphenyl)-cyclohexan-3-one (IV) by Friedel–Craft condensation between anisole and 4-methyl-4-carbethoxycyclohexene-3-one (III). In the present communication, the study of the condensation of methyl 4-methyl-4-carbomethoxycyclohexene-3-one-2-acetate (V, $\lambda_{max.}$ 235 mμ, log ε 3·8) with anisole is reported. The reaction was carried out in the cold with a solution of (V) in anisole in a slow stream of dry hydrogen chloride and in the presence of anhydrous aluminium chloride. The condensation product, obtained as a glass, was hydrolysed and decarboxylated in 80 per cent yield to give a mixture of two isomers of 4-methyl-(*p*-methoxyphenyl)-cyclohexan-3-one-2-acetic acid (VI, *A* and *B*, melting points 208° and 135°) in the ratio 1 : 7, respectively. The isomer *B* was also obtained by Johnson and Christiansen by the hydrolysis of their keto-diester II (private communication). A direct comparison of the mixed melting point of our isomer *B*, melting point 135° with an authentic specimen, kindly supplied by Dr. W. S. Johnson, showed no depression. The recent successful conversion of (II) to œstrone (I) makes further work in this line unnecessary.

The unsaturated keto-ester (V) was prepared by the following method. Methyl hexane-1,2,6-tri-



(I)



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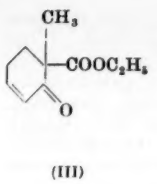
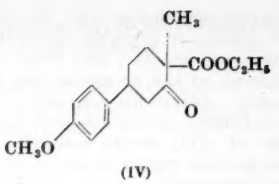
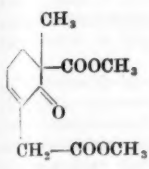


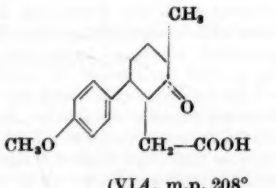
(III)



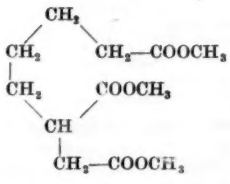
(IV)



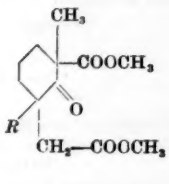
(V)



(VI*A*, m.p. 208°
VI*B*, m.p. 135°)



(VII)



carboxylate (VII), prepared from ethyl 2-carbethoxycyclohexanone-2-acetate[3], was cyclized in benzene solution with sodium dust in an atmosphere of nitrogen, and the resulting sodio derivative was directly treated with an excess of methyl iodide to furnish the methylated β-keto-ester (VIII, $R = H$; $n_D^{25°}$, 1·4649) in 88 per cent yield. This ester reacted smoothly with a molar quantity of bromine in carbon tetrachloride solution to give the solid bromo compound (VIII, $R = Br$; melting point 94–95°) in 80 per cent yield. The latter on dehydrobromination by treatment with dimethylaniline gave methyl 4-carbomethoxycyclohexene-3-one-2-acetate (V, $n_D^{25°}$, 1·5141) in 75 per cent yield.

In view of the good yield in each step of the above preparation, the present method for the preparation of the key intermediate II, in the synthesis of œstrone (I), appears to be an attractive one.

Our thanks are due to Dr. D. K. Banerjee, professor of organic chemistry, College of Engineering and Technology, Bengal, for his suggestions, and to Dr. William S. Johnson, of the University of Wisconsin, for supplying an authentic specimen of VI, *B*.

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March 10.

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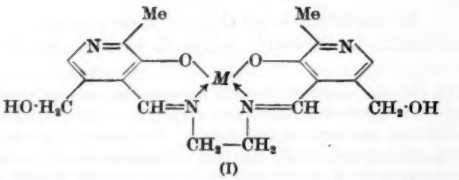
Pyridoxal Derivatives in Transamination

In living systems a transfer of amino groups occurs between certain amino-acids and keto-acids. This important reversible process, known as 'transamination'[1], effects a link between carbohydrate and protein metabolism, and the responsible enzymes, the transaminases, are activated by pyridoxal[2] or pyridoxamine phosphates[3]. The proposed mechanisms of the reaction involve participation of a Schiff base between amino- and keto-acids[4] or between amino-acids and pyridoxal phosphate[5]. Prototropic rearrangement followed by hydrolysis gives, respectively, the keto- and amino-acids or the keto-acid and pyridoxamine phosphate, the latter then undergoing a reverse reaction with a different keto-acid. A reversible, non-enzymic reaction between pyridoxal and amino-acids to give pyridoxamine and keto-acids, discovered by Snell[6], was shown recently to be catalysed by trace metals (copper, iron, aluminium)[7]. Interest in this chemical process lies mainly in its possible connexion with the biological one; therefore an explanation of the part played by metals in such reactions is clearly desirable.

Pyridoxal is a typical phenolic aldehyde, resembling salicylaldehyde in many of its reactions. It has been found that this similarity can be extended to the formation of metallic complexes between pyridoxal, ethylenediamine and metal salts. These co-ordination compounds are analogous to those formed with salicylaldehyde[8] and have the probable structure (I).

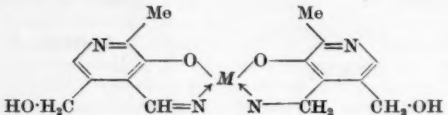


(I)

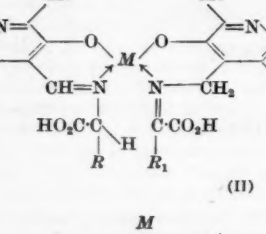
The compounds of copper, nickel and magnesium were sparingly soluble in water and could be isolated; those of iron, manganese and cobalt were too soluble, but their formation in solution was evident from the marked colour changes observed on mixing the components. Furthermore, similar compounds were formed when two moles of an amino-acid were substituted for the ethylenediamine. Pyridoxal formed green copper complexes with all the amino-acids examined (glycine, alanine, serine, lysine, *iso*leucine, valine, threonine, methionine). In most cases these were too soluble for isolation, but their formation was observed by the characteristic green solutions produced on mixing the components (in the absence of pyridoxal the typical deep-blue copper-amino-acid complexes were produced). The green colour persisted in acetic acid solution but was destroyed by mineral acids. The tyrosine compound was sufficiently insoluble for isolation (found C, 45·6; H, 5·0; N, 6·4; Cu, 14·5; $C_{24}H_{32}O_{10}N_4Cu_2 6H_2O$ requires C, 45·6; H, 4·9; N, 6·3; Cu, 14·3 per cent).

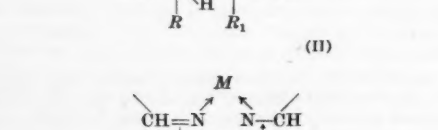
In view of the ready formation of such compounds, it is possible that, in a solution containing pyridoxal, pyridoxamine, an amino-acid and a keto-acid, mixed co-ordination compounds of the type (II) would be formed. The sharing of the lone electron pairs of the

two nitrogen atoms with the metal would facilitate the release of protons from the α-position of the amino-acid residue, and from the methylene group adjacent to the aromatic ring in the pyridoxamine moiety. Electronic displacements might then occur as indicated, giving rise eventually to (III). Hydrolysis of (III) would complete the transamination. The process would be reversible and an equilibrium state attained.



(II)





(III)

In the non-enzymic reaction only two components, together with cations, were required; for example, pyridoxal and an amino-acid. However, the other components necessary for the formation of (II) could be formed to a small extent in the initial stages by spontaneous reaction.

The significance of these proposals in biological transamination is not yet clear. Cations are known to be essential for the proper functioning of many enzymes, but the transaminases have not yet been obtained sufficiently pure to ascertain their cation requirements. If a similar mechanism does operate, then it becomes possible to ascribe functions to most of the groups in the coenzymes. The aldehyde (or amino) and phenolic groups would be involved in the transamination proper, while the ring nitrogen and phosphate group (on the 5-hydroxymethyl) would participate in electrovalent linkage with a protein.

Thanks are due to Roche Products, Ltd., for a gift of pyridoxal.

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July 15.

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Production of Antibiotic Substances by the Roots of a Grass (*Trachypogon plumosus* (H. B. K.) Nees) and of *Pentanisia variabilis* (E. Mey.) Harv. (Rubiaceæ)

During the course of a study of the rate of nitrification in soils taken from plant communities representing various stages of the secondary grassland succession on the Transvaal Highveld, it was found that soils taken from the *Trachypogon plumosus* grassland climax community showed a consistent lag in the production of nitrate.

The experimental methods were as follows. (1) Soils were moistened and incubated for several weeks; the flasks were weighed initially, and reweighed from time to time, the loss of weight being made up with distilled water. These soils were then analysed for nitrate-nitrogen and ammonium-nitrogen. (2) Soil columns were perfused with distilled water using the Lees and Quastel perfusion technique. The perfusate was analysed for nitrate-nitrogen and ammonium-nitrogen from time to time. (3) Whole plants with their surrounding soil cores were placed in large pots. The aerial parts were removed completely, leaving an undisturbed soil and root system in the pots. Rain-water that percolated down through the soil cores was collected and analysed for nitrate-nitrogen and ammonium-nitrogen. Botanical analyses were carried out on the soil surfaces of the pots from time to time as plant growth regenerated.

It was found that, in the pots containing the *Trachypogon plumosus* root and soil, (*a*) little or no nitrate was produced; (*b*) the regeneration of plant growth was practically negligible.

It was thought from these observations that the roots of *Trachypogon plumosus* were secreting antibiotic substances which were inhibiting the activity of nitrifying organisms, and also seemed to be inhibiting the germination of weed seeds, and the growth of weed seedlings.

Roots of *Trachypogon plumosus* were collected, washed free of all soil particles and an extract was made with distilled water. This extract was tested by the agar cup method on plates seeded with *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus* (Oxford strain) and *Streptococcus hæmolyticus* (Richard strain). Very clear, wide zones of inhibition were displayed on all plates. So far as we know, this is the first instance where grass roots have been shown to exhibit antibiotic properties.

The possibility of other plants in this community containing antibiotic substances arose, and several grasses and non-grasses were treated accordingly. Three other non-grass plants were found to show antibiotic activity. Two of them displayed only slight activity against *E. coli* and *B. subtilis*, but *Pentanisia variabilis* (Rubiaceæ) showed very marked activity against *E. coli* and *B. subtilis*, and slight activity against *Staphylococcus aureus* and *Streptococcus hæmolyticus*.

An antibiotic assay of most of the important plants growing in the *Trachypogon plumosus* grassland climax community is at present being carried out. Further work on the antibiotic principle of *Trachypogon plumosus* and its effects on nitrifying organisms and weed seeds is proceeding.

I wish to acknowledge the advice and assistance given by Prof. N. P. Badenhuizen, Botany Department of the University of the Witwatersrand, Prof. J. J. Theron, Department of Agricultural Chemistry

of the University of Pretoria, and Dr. J. Murray, South African Institute for Medical Research.

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Microbiological Decomposition of Malto- and Lacto-bionate

Stodola and Lockwood[1], and Kluyver, De Ley and Rijven[2], demonstrated that several species of *Pseudomonas* are able to oxidize maltose and lactose to the corresponding malto- and lacto-bionic acid, by oxidation of the reducing group of the disaccharide, without breaking the oxygen bridge. Some strains of *Pseudomonas* consume the calcium salt of these acids slowly[2]. *Pseudomonas* is a common surface inhabitant of several natural waters, so it is likely that under these natural conditions these cells may convert maltose from polysaccharides (formation of lactose is improbable) into the corresponding acid. It seemed to be of interest to ascertain what kind of micro-organisms are endowed with the ability to consume maltobionate, with the view of getting an idea of the importance of this decomposition process in Nature. Lactobionate was included in view of a future study of the enzymatic mechanism of its breakdown.

Petri dishes, containing agar, with potassium, ammonium and magnesium sulphates, yeast extract, calcium carbonate and a calcium bionate, were inoculated with ditch- and river-water, stagnant water, soil, humus, dune-sand, etc., and incubated, usually at 25°–30° C., one set aerobically, another anaerobically. Growth in anaerobic conditions was scanty, and only a few colonies developed on bionates. On the other hand, there was a luxurious aerobic growth on bionates and a great variety of microflora developed. Of these, more than sixty strains have been isolated and investigated. These strains quickly consume malto- or lacto-bionate, or both, in a liquid culture medium when incubated for plentiful aeration in a shaking device in an incubator room at their optimal temperature. The consumption of bionates was determined by the titrimetric method of Kluyver, De Ley and Rijven[2]. The accompanying list indicates the bacteria found (nomenclature according to "Bergey", 6th edit.; quantitative data will be published elsewhere): *Escherichia freundii* or *intermedium*; *Paracolobactrum aerogenoïdes*; *Aerobacter aerogenes*; *Aerobacter cloacæ*; *Serratia plymuthicum*; *Alcaligenes fæcalis*; *Achromobacter* sp.; *Flavobacterium* sp.; *Corynebacterium simplex* and *helvolum*; *Pseudomonas fluorescens* and sp.; *Bacillus megatherium* and *circulans*. Several other bacteria, as yet unidentified, are able to consume malto- and/or lacto-bionate. Usually several different strains of the same micro-organism were isolated. *E. coli* strains are unable to consume maltobionate; some decompose lacto-bionate slowly. Most of the above-mentioned strains decompose both bionates. Only maltobionate can be broken down under anaerobic conditions by some strains of *Aerobacter*. The following moulds decompose maltobionate: *Penicillium* sp.; *Hormodendrum cladosporoïdes*; *Aspergillus* sp.; *Fusarium merismoïdes*, *avenaceum* and *oxysporum*. It is remarkable that no yeasts were detected.

Most of the bacteria grow well on the corresponding disaccharide. Some of the apparent exceptions are under investigation.

The following scheme of maltose decomposition in natural surface waters is proposed, this being additional to those already known:

Maltose
↓ *Pseudomonas*
Maltobionate
↓ obligate aerobic micro-organisms, Enterobacteriaceæ
Glucose and gluconate
or
unidentified pathway.

The large number of strains observed suggests that this pathway for the metabolism of maltose may be quite important in Nature.

A full account of these and related results will be published elsewhere. We also hope to publish a preliminary investigation of the enzymatic mechanism in the near future. We are indebted to Sandoz, Ltd. (Switzerland), for a generous gift of lactobionate.

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J. DE LEY

Biochemical Laboratory,
Veterinary College,
State University, Ghent.
April 12.

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Deoxyribonucleic Acid Content of Haploid and Diploid *Aspergillus* Conidia

In 1948, Boivin, Vendrely and Vendrely[1] suggested that the somatic nuclei of a vertebrate species may contain a fixed amount of deoxyribonucleic acid that is double the amount present in the germ cells. Since then, a considerable volume of evidence has been obtained to support this view[2,3]. Some apparent exceptions, such as rat liver, have been found, but these can be explained by the presence of nuclei with different degrees of 'ploidy'. The evidence is consistent with the view that in resting nuclei a specific amount of deoxyribonucleic acid is associated with each set of chromosomes[4].

In vertebrate tissues it is difficult to make sure that a tissue has a population of nuclei homogeneous in respect of the number of chromosome sets. Therefore we have thought it of use to investigate the deoxyribonucleic acid content of conidia of diploid and haploid strains of *Aspergillus nidulans*[5]. These conidia are uninucleate; genetic and cytological evidence shows that in different strains the nuclei are either diploid or haploid, and in the conidia the nuclei are all uniformly in one stage, presumably the resting stage. The volumes of the diploid and haploid conidia are[5,6] in the ratio of 2 : 1.

Two haploid strains were used: the wild type (+, green conidia) and a mutant strain (w_8) with white conidia[7]. Two diploid strains heterozygous for known markers were prepared[5]: one with green conidia (w_8 *lys*/ad_2 *y*) and the other with white conidia (28-*a*). The latter strain was obtained through somatic recombination[6,8] from a green diploid (w_8 $paba_1$ bi_1/ad_2 *y*). Cultures were grown on a minimal agar medium containing glucose and mineral

salts. The conidia were harvested in saline containing 0·1 per cent calzolene oil and were counted in a hæmocytometer. They were precipitated with 0·5 vol. 30 per cent trichloroacetic acid and extracted successively with 10 per cent trichloroacetic acid (twice), acetone, ethanol, hot ethanol : chloroform 3 : 1, hot ethanol : ether 3 : 1 (twice) and ether. The dry powder obtained was extracted[8] with 5 per cent trichloroacetic acid at 90° for 15 min., and the deoxypentose in the extract was estimated by the diphenylamine method[10] with incubation at 37° for 18 hr. The results are expressed in terms of deoxyribonucleic acid phosphorus, the method having been calibrated with purified thymus deoxyribonucleic acid.

Strain	Deoxyribonucleic acid phosphorus (10^{-12} gm. per 10^3 conidia)
Green haploid	4·04
Green diploid	9·39
White haploid	4·22
White diploid	7·75

Within the limits of the methods, these figures are consistent with a deoxyribonucleic acid ratio of 1 : 2 for the conidia from haploid and diploid strains.

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Efficiency of Growth in *Mytilus edulis* and Two Gastropod Veligers

Growth efficiencies have been studied extensively in domestic animals and in some common laboratory animals[1]. Little is known, however, of the utilization of energy in the growth of lower animals. I have been able to show that marine invertebrates may have high growth efficiencies. Efficiency calculations were based on growth-rate and oxygen uptake in *Mytilus edulis* of different ages, and in veligers of two marine gastropods, *Littorina littorea* and *Nassa reticulata*. Rates of growth were calculated from average increases in length in Nature during known intervals of time. Data published by Thorson[2] were used in calculating growth-rates of veligers of *Littorina* and *Nassa* (from the Isefjord, Denmark) and of young metamorphosed *Mytilus* (from the Sound). I myself measured the growth of *Mytilus* veligers (from Isefjord). Data on growth of *Mytilus* during later stages were obtained from the Pacific off La Jolla, California, where Coe[3] measured the average increment in length of different age- and size-groups during August–November while maximum growth is taking place. Lengths were first converted into total nitrogen content using the relationship found by Zeuthen[4] (and unpublished results of Dr. Zeuthen). Then total organic matter was computed, assuming a nitrogen content of 8 per cent of the dry organic matter. Rates of oxygen uptake were obtained from Zeuthen[4]. The oxygen values were converted into organic matter by assuming that 1·2 litres of oxygen is equivalent to 1 gm. of organic matter.

	Length (mm.)	Nitrogen content (γ-nitrogen)	Daily increase in organic matter (per cent)	Daily combustion of organic matter (per cent)	Gross efficiency of growth (per cent)
Mytilus edulis veliger	0·09–0·26	0·003–0·07	11·2	4·2	73
Mytilus edulis metamorphosed	0·35– 6·0	0·2–100	14·4	2·8	84
	11·0–22·3	530– 2,900	5·7	1·8	76
	21·0–32·1	2,500– 7,000	3·4	1·5	69
	31·0–40·9	6,500–12,000	2·0	1·3	61
	40·9–49·0	12,000–18,500	1·4	1·2	54
	51·0–56·9	21,000–27,000	0·8	1·0	44
	61·0–63·8	32,000–36,000	0·4	1·0	29
	90·0–90·8	82,000–84,000	0·1	0·8	11
Littorina littorea veliger	0·20–0·38	0·02–0·22	9·0	5·4	62
Nassa reticulata veliger	0·30–0·56	0·13–0·63	9·3	5·4	63

From the accompanying table it is seen that the efficiency of growth is of the same order in veligers of *Mytilus*, *Littorina* and *Nassa*. Furthermore, the efficiency of growth in *Mytilus* does not significantly change on metamorphosis. Owing to the heterogeneity of the material the increase in efficiency indicated in the table is probably not significant. A pronounced decrease in efficiency starts at a length of about 30 mm., when the growth-rate drops to about 2 per cent daily. Harvey[5] calculated that the efficiency of growth in the marine copepod *Calanus finmarchicus* was about 70 per cent. The growth efficiencies in *Calanus*, *Littorina*, *Nassa* and *Mytilus*, up to a length of about 50 mm., fall close to the values found in embryos. The gross efficiencies of growth of embryos for the hen, frog, fish and silkworm are 62, 51, 59 and 65 per cent, respectively (Brody[1], pp. 43–44). Maximum efficiencies of postnatal growth are generally found to be lower than in these marine invertebrates ; for example, 20–40 per cent in pig, trout and cockroach[6].

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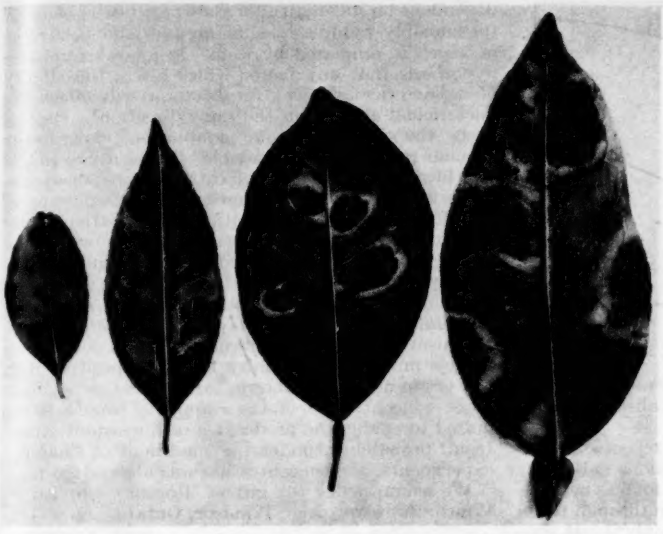
Molybdenum Deficiency in Florida Citrus

Investigations at this Station have disclosed that molybdenum deficiency is found in citrus trees throughout the citrus-growing area of Florida. The symptom of this deficiency has been called yellow spot since it was first described by Floyd[1] in 1908. Yellow spot has also been reported in citrus on the Isle of Pines[2]. Repeated studies[3] failed to demonstrate that it was due to an infectious fungus, bacterium or virus. It is known to occur on practically all kinds of citrus ; but the rootstock greatly affects the extent



Molybdenum deficiency of citrus leaves. Left to right leaves from Temple orange, tangerine, orange and grapefruit

to which the tree is injured. Trees on grapefruit rootstock are much more seriously affected than are trees on other rootstocks. This is one of the reasons why grapefruit has not been widely used as a rootstock in Florida.

Molybdenum deficiency in citrus appears first as water-soaked areas in leaves in the early spring. In the summer, these areas develop into large interveinal yellow spots with gum on the lower leaf surfaces (see photograph). Badly affected leaves eventually drop, and in extreme deficiency the trees become almost completely defoliated during the winter.

Molybdenum foliage sprays caused the yellow spot leaves to become green within three to four weeks after application. Some response was obtained when as little as 0·1 gm. of sodium molybdate was applied per tree. The lowest amount which gave a satisfactory response was 0·1 ounce per tree applied as a spray in 10 gallons of water. Equivalent amounts of ammonium molybdate have been equally as effective as the sodium salt. When 1 gallon of a solution containing 1 gm. sodium molybdate was injected under pressure into the trunk of a yellow spot tree, using an apparatus similar to that described by Southwick[4], the leaves became completely green within ten days.

The amount of molybdenum required by citrus is very small. Vanselow and Datta[5] in greenhouse studies found that molybdenum deficiency showed up in lemon trees in which the dried leaves analysed spectrographically contained 0·02–0·03 p.p.m. molybdenum. Chemical analyses made at this Station showed that the molybdenum content of yellow spot leaves from grapefruit and orange trees varied from 0·03 to 0·08 p.p.m. The molybdenum content of leaves from nearby green trees was found to be slightly higher in each instance. Samples of leaves taken from two yellow spot trees three months after soil applications of 1 gm. and 1 ounce of sodium molybdate were made showed the leaves contained 0·05 and 0·08 p.p.m. of molybdenum respectively. There was no noticeable greening of the leaves six months after the soil application.

Molybdenum sprayed on trees did not appear to be readily translocated. When the lower halves of grapefruit trees were sprayed with 1 ounce of sodium molybdate, leaves that were covered with the spray became green whereas those in the tops of the trees remained yellow and eventually dropped.

The total molybdenum content of Florida citrus soils has been found to be very low, ranging from 0·20 to 0·40 p.p.m. Water extractions were made on a large group of Florida soils and the amount of soluble molybdenum was found to be less than 0·001 p.p.m.

Studies[3] have shown that the amount of molybdenum taken up by plants increases with increasing *p*H of the soil. Grapefruit trees in plots at the Citrus Experiment Station growing on soil having a *p*H of 4·2 were severely affected with yellow spot, which caused almost complete defoliation of the trees. Chemical analysis of the leaves indicated they contained 0·03 p.p.m. molybdenum. Trees were green on adjacent plots where the soil had been limed to *p*H 5·6. The molybdenum content of leaves from these plots was found to be 0·06 p.p.m.

This is believed to be the first time that symptoms on trees growing in soil have been identified as due to molybdenum deficiency.

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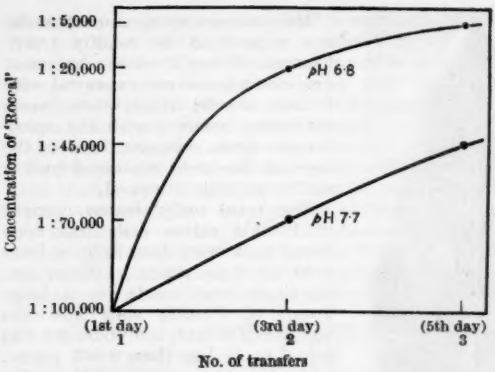
Factors Governing the Adaptation of Bacteria against Quaternaries

CHAPLIN has shown[1] that, contrary to a view current until then[2], it is possible to increase the resistance of certain Gram-negative bacteria to some quaternaries such as the cationic detergent 'Roccal' (alkyldimethylbenzyl ammonium chloride).

Using a sensitive strain of *Serratia marcescens* (obtained through the courtesy of Dr. C. E. Chaplin), we were able also to grow cultures resistant to higher concentrations of 'Roccal'. The experiments involved three direct transfers, namely, from a 1 : 100,000 dilution of 'Roccal' in nutrient broth containing 0·5 per cent 'Trypton' and of 'Peptone Difco', to one of 1 : 20,000 and then to one of 1 : 5,000; the *p*H of the media was found to be ~ 6·8 but varied slightly with the amount of 'Roccal' used. However, the bacteria adapted in this way did not survive when transferred to a nutrient broth containing



'Roccal' of a concentration of 1 : 5,000 at a *p*H of 7·4, but they survived at this *p*H in the absence of the quaternary.

When the above experiments were repeated under slightly alkaline environmental conditions (*p*H 7·7), the same dependence upon *p*H was found, because we were able to increase the resistance through three direct transfers from 1 : 100,000 to only 1 : 45,000, corresponding to a 2·2-fold higher concentration of 'Roccal' instead of the 20-fold reached when the *p*H was on the acid side; since we were mainly interested in the dependence on *p*H and not in the extent of the adaptation possible, we did not consider it necessary to carry out a greater number of transfers. In both experiments there is a maximum concentration for each transfer above which there is no survival. These concentrations are those used in our experiments and shown in the graph.

The results indicate that the adaptation is dependent on the *p*H of the medium, just as the bactericidal activity is. The bactericidal activity of a cationic compound is known to be enhanced by a rise in *p*H and to be diminished by a lowering of *p*H [3]. The rule has been shown to govern the affinity of a cationic compound for wool, and formed part of a general relationship found to hold between the bactericidal activity of a compound and its affinity for wool[4].

Quaternaries have a higher bactericidal activity against Gram-positive bacteria than against Gram-negative[3,5] bacteria. We have shown that such compounds, as exemplified by 'Bradosol' (phenoxyethyldimethyldodecyl ammonium bromide), have a higher affinity for a degraded wool, which we have taken to simulate the behaviour of Gram-positive bacteria, than for intact wool, the model for Gram-negative bacteria[6]. We conclude from this that the bactericidal activity of a substance is largely dependent on its affinity for that part of the bacteria (presumably cytoplasmic membrane) the behaviour of which is simulated by wool. It follows from this hypothesis that any factor which alters the affinity of a bactericidal agent for bacteria will affect the bactericidal activity in the same direction[7]. On this basis the results of our adaptation experiments become readily understandable. Since a rise in *p*H will increase the affinity of cationic substances, the bactericidal activity will increase, and it will require, therefore, a lower concentration of the cationic substance to produce the same effect as shown in the graph and further supported by the results in the accompanying table.

Bactericidal Activity of 'Roccal' against *S. marcescens* after 24-hr. Contact in Nutrient Broth, at Different *p*H's

Concentration of 'Roccal' in nutrient broth	*p*H 6·8	*p*H 7·4	*p*H 7·8
1 : 325,000	−	−	−
1 : 250,000	−	−	−
1 : 175,000	−	−	−
1 : 100,000	−	−	+
1 : 70,000	−	+	+
1 : 45,000	+	+	+
1 : 20,000	+	+	+
1 : 10,000	+	+	+
1 : 5,000	+	+	+

+, indicates activity*; −, indicates absence of activity.
* A reinoculation into fresh media was made to confirm that we were dealing really with a bactericidal action and not a bacteriostatic one.

A similar explanation can be used to show why Chaplin[1] was unable to render a Gram-positive organism resistant to quaternaries. Such compounds have a much higher affinity for Gram-positive than for Gram-negative bacteria, and therefore a much lower concentration of the compound would be required to enable the production of a resistant strain. In all probability, under the conditions of Chaplin's experiments, the concentration was always too high.

We acknowledge the gift of 'Roccal', supplied by Winthrop-Stearn, Inc., Windsor, Ontario.

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Distribution of Dextran in the Tissues of Rabbits

The increasing use of dextran solutions as plasma substitutes has made the problem of the fate in the organism of the injected polysaccharide a very important question. Several studies on this problem have been carried out by means of chemical and serological methods of determination of dextran in extracts of tissues[1], and a few histological investigations are recorded in the literature. The methods used in these studies are, however, inadequate, as they do not allow any conclusions to be drawn as to the nature of the deposits found in the tissues after injection of dextran.

It has been demonstrated by several investigators that a considerable part (about 25 per cent) of the dextran injected is excreted through the kidneys within a few hours. Others have suggested that a portion is eliminated by the intestinal tract[2]. But what becomes of the remaining dextran that slowly disappears from the blood without being detected either in the urine or in the fæces? Some authors postulate a breakdown of the polysaccharide to glucose units, which are metabolized in the body[3]. The localization of such processes is undetermined. A transient accumulation of dextran outside the vessels may be suggested, and the presence of dextran has been demonstrated in lymph nodes and spleen by the use of chemical and serological methods.

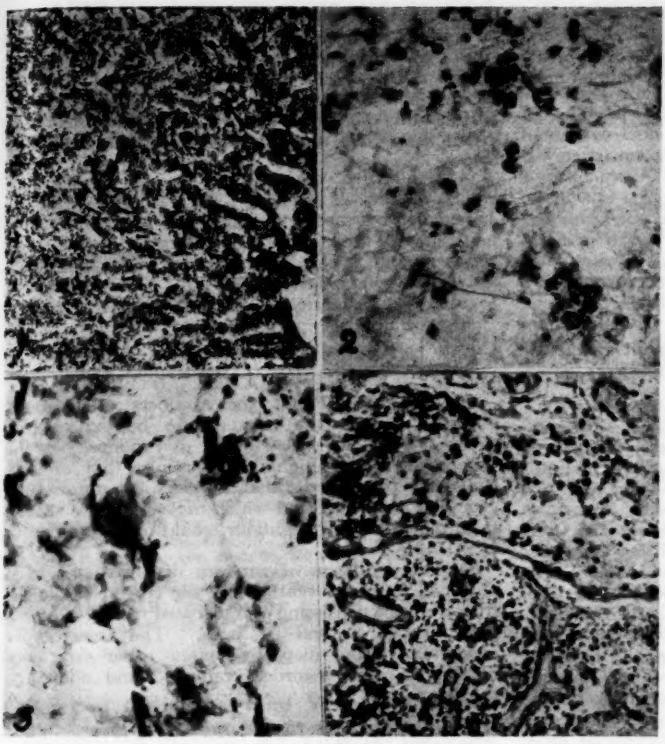

Fig. 1. Dextran inclusions in liver cells and Kupffer cells 48 hr. after injection of 'Macrodex'. Modified *PAS* reaction

Fig. 2. Polymorphonuclear leucocytes loaded with dextran 4 hr. after injection of 'Macrodex'. Modified *PAS* reaction

Fig. 3. Bone marrow with reticular cells loaded with dextran granules, 96 hr. after injection of 'Macrodex' intravenously. Modified *PAS* reaction

Fig. 4. Lymph node containing many macrophages filled up with dextran, 48 hr. after administration of 'Macrodex' intravenously. Modified *PAS* reaction

In order to follow the distribution of injected dextran ('Macrodex', Pharmacia) in various organs and tissues in rabbits, a series of histochemical investigations was started late in 1950. The determinations were based on the use of the periodic acid – leucofuchsin method. In order to assure a certain specificity to the reaction against dextran, the procedure described by Hotchkiss was somewhat modified. Furthermore, adjacent sections were treated with other oxidizing agents (chromic acid and permanganate), and with iodine and azur *A*. Thus it was possible to distinguish dextran from other polysaccharides in the sections. Detailed descriptions of the methods used are to be published elsewhere.

The present communication gives a short summary of the results of a series of histochemical investigations on 104 rabbits given 6 per cent 'Macrodex' parenterally in doses of 20 ml./kgm. body-weight. The organs and tissues of the animals were studied at intervals varying from 15 min. to 80 days after the administration of dextran. Liver, kidneys, spleen, lymph nodes, bone marrow, blood leucocytes, stomach, small intestine, thymus, adrenals, omentum and skin were examined.

Kidneys. The passage of the low-molecular part of the 'Macrodex' through the glomerulus and nephron during the first few hours after injection was well demonstrated in the sections. A small, transient deposition of dextran granules in the cells of the convoluted (proximal and distal) tubules was noted within the first twelve hours. No traces of dextran were visible in the tubular epithelium 48 hr. after administration.

Liver. The uptake of dextran by the liver cells was visible about 24 hr. after injection of 'Macrodex'. Some of the livers studied were deprived of most of their ordinary glycogen content by starving the animals for 24 hr. before autopsy. The dextran granules deposited in the liver cells were of uniform size, and scattered over the whole area of the cell without forming any floccules like glycogen (Fig. 1). Dextran inclusions were visible up to three days after administration. No dextran was observed in the bile ducts.

Blood leucocytes. An accumulation of dextran occurs very rapidly in the polymorphonuclear leucocytes. Within 15 min. of intraperitoneal or intravenous injection of 'Macrodex', a great many granulocytes were seen to be packed with dextran granules. The number of leucocytes with dextran inclusions was at a maximum 3–4 hr. after administration. At this time such cells are seen everywhere in the small vessels and in loose connective tissue (Fig. 2). In the spleen, dextran-loaded leucocytes are retained for several days. The histochemical properties of the dextran granules in the leucocytes differ from those observed with dextran *in vitro*. This may be due to a change in the chemical structure of the substance due to some enzymatic attack on the dextran molecule.

Reticulo-endothelial system. The spleen, lymph nodes, bone marrow and the Kupffer cells of the liver were studied as being important parts of the reticulo-endothelial system. The uptake of dextran by reticulo-endothelial cells was similar in all the organs and tissues studied. A moderate amount of the polysaccharide was visible within the cells about 12 hr. after intravenous injection of 'Macrodex'. The accumulation of dextran increased and showed a definite peak 48–96 hr. after administration. Especially in the bone marrow and lymph nodes, a great number of reticular cells and macrophages completely filled with dextran granules was visible (Figs. 3 and 4). Twelve days later, it was still possible to see a moderate number of dextran-loaded reticulo-endothelial cells in the bone marrow and lymph nodes. Thirty days after the injection of 'Macrodex', the reticulo-endothelial cells did not differ from those in the controls.

These observations suggest that the liver cells, the polymorphonuclear leucocytes, and the reticulo-endothelial cells, all of which are known to be enzymatically very active, play a part in breaking down dextran into units that can be utilized by the body or which can be easily eliminated from the organism. An interesting problem in this connexion is the effect

of the accumulated dextran on the various physiological properties of the reticulo-endothelial system. Work on this subject is in progress in our laboratories.

Detailed reports on the results briefly outlined here will appear elsewhere.

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Airborne Dispersal of *Phytophthora palmivora*, causing Black-Pod Disease of *Theobroma cacao*

At the 1951 Cocoa Conference, Mr. G. F. Bowman, chief of the American Cacao Research Centre, Turrialba[1], referred to work by Salazar[2] which shows that the sporangia of *P. palmivora* are almost certainly not airborne, except in drops of water. Contrary evidence was not apparently produced at the Conference; therefore it is desirable to direct attention to certain observations in Nigeria which indicate that *P. palmivora* sporangia may be airborne and that infection apparently results thereby. In this respect, the species in question would appear to be comparable with *P. infestans* in temperate regions, the airborne dispersion of which has been discussed by Gregory[3] and by Van der Plank[4]. It seems necessary to postulate long-distance dispersal to explain the epidemiology of black-pod disease. Observations have therefore been made to test this hypothesis, and also to determine whether free moisture is essential for take-off and dispersal of sporangia in Nigeria.

Sporangia have been observed on 'Vaselined' disks of 'Cellophane' (3 mm. diameter), mounted on pins above the surface of an infected pod. The arrangement was generally such that the disk was facing the sporangia and parallel with the pod surface. The distance between the disk and the pod varied from approximately 5 mm. to about 20 mm. Six or more disks per pod were exposed for 12-hr. periods (7 a.m.–7 p.m. and 7 p.m.–7 a.m.). The maximum mean number of sporangia found per disk was 2·3, but generally the mean number was less than one per disk. Sporangia were caught on disks when free moisture was apparently absent during the exposure period. It should be noted in this connexion that Ashby[5] stated regarding *P. palmivora* in culture that "the sporangia when mature fall away from the sporangiophores by natural abscission . . .". This observation lends support to the experiments now described, which indicate that take-off of sporangia can occur without the assistance of water.

It is possible that Salazar's[2] failure to catch sporangia on plates may have been due to the relative inefficiency of large 'traps', which has been established by Gregory[3]. Small disks have been used in Nigeria because they are likely to be relatively efficient under the conditions of low wind velocity ($\frac{1}{2}$–1 m.p.h.), which prevail locally[7]. Having established the possibility of air dispersion of sporangia, it is necessary to ascertain whether the occurrence of the disease is in conformity with this finding.

Van der Plank[6] has described a procedure which is suitable for the examination of black-pod disease distribution in cacao fields, by observing the number of doublets (pairs of affected trees) in sequences of trees. In this connexion, it is convenient to describe a tree as 'diseased' when it carries one or more affected pods, as opposed to a 'healthy tree' carrying only healthy pods. Results from observations made in the same field on two occasions are summarized below.

Table 1. Incidence of Doublets of Diseased Trees in a Cacao Field

Date	No. of trees observed (healthy + diseased)	No. of diseased trees	No of doublets		Difference (observed − expected)	Standard error ±
			Observed	Expected		
29/5/50	451	55	7	6·6	0·4	2·57
10/7/50	303	244	207	195·7	11·3	13·99

Table 1 shows that the numbers of doublets observed exceed the numbers to be expected if diseased trees were distributed at random, but the differences are not significant, because they are less than their respective standard errors. Therefore such grouping as occurs, and which may be due to spread from neighbour to neighbour, could occur by chance ($P > 0{\cdot}05$).

Further evidence of random dispersal has been obtained from observations on the spread of disease from a source consisting of a diseased tree with black-pods heaped around its base. The trees under observation were inspected every other day, and black-pods were recorded, removed and added to the heap.

Table 2. Spread of Black-Pod Disease from a Source of Infection

Distance from source (m.)	0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90
Diseased trees (per cent of total trees)	33	35	37	25	22	23	13	24	29
No. of diseased pods (per 100 trees)	69	85	98	45	48	34	23	43	44

There are indications of a decreasing gradient of infection from 0–70 m.; but from 71–90 m. there would appear to be an opposing gradient which may have been due to extraneous infection coming from some source beyond the observation area. The heap of pods occupied a space about 8 ft. in diameter, therefore it could not be properly considered as a point-source, which may partly account for the 'flatness' of the gradient in the interval 0–30 m. The results suggest random distribution from a central source, because an approximation to a straight line is obtained when the logarithm of the percentage of healthy trees is plotted against the number of diseased pods[8]. In connexion with the possible origins of extraneous infection, it is worth mentioning that there is no direct evidence under local conditions for the natural production of *P. palmivora* sporangia from alternative hosts or on parts of the living cacao tree except the pods. Sporangia have been observed on chupons (vertical stems) following artificial inoculation.

It has been shown that there is evidence for horizontal dispersion of black-pod disease in a random manner, such as would be expected for an airborne disease. There is also evidence for vertical spread in such a way that healthy pods become infected from diseased pods several feet below. It is probable that sporangia are commonly dispersed from infected pods in splash droplets, but there is evidence that take-off can occur in 'dry' air; it appears that sporangia may be airborne over considerable distances.

Phytophthora palmivora can readily infect healthy pods through wounds; hence there is a possibility that some pod infection may be associated with insect damage. Most of the pod damage by insects in Nigeria is ascribed to *Helopeltis* sp., but casual observations indicate that it is only exceptionally that black-pod infection is associated with such insect punctures.

Black-pod disease studies are continuing and detailed results will be published elsewhere. I am greatly indebted to Dr. P. H. Gregory, Rothamsted Experimental Station, for his advice and suggestions adopted in the preparation of this communication, which is published with the permission of Mr. A. G. Beattie, Inspector-General of Agriculture, Nigeria.

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April 16.

[1] Bowman, G. F., Report of Cocoa Conference, 1951, p. 49 (Cocoa, Chocolate and Confectionery Alliance Ltd., London).
[2] Salazar, M., thesis in library of I.A.I.A.S., Turrialba (not seen); abstract in *Cacao Inform. Bull.*, **1**, No. 18 (1949).
[3] Gregory, P. H., *Trans. Brit. Myc. Soc.*, **28**, 26 (1945).
[4] Van der Plank, J. E., *Emp. J. Exp. Agric.*, **17**, 18 (1949).
[5] Ashby, S. F., *Trans. Brit. Myc. Soc.*, **14**, 34 (1929).
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[7] Anonymous, "Weather on the West Coast of Tropical Africa", M.O. 492 (H.M. Stationery Office, 1949).
[8] Van der Plank, J. E., *Trans. Roy. Soc. S. Africa*, **31**, 269 (1944).
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Gilbert of Colchester and Wingfield House

DR. WILLIAM GILBERT, who wrote the celebrated treatise, "De Magnete", and who was physician to Queen Elizabeth I and president of the College of Physicians, lived and worked in London in a "capital messuage or mansion" called Wingfield House. There, in a bachelor establishment, he gathered about himself a group of students of the new learning and developed the scientific method of inductive reasoning, his "new sort of philosophising", which he applied to experiments on magnetism and static electricity.

Wingfield House was in St. Peter's Hill, in the parish of St. Peter, Paul's Wharf. So much is apparent from published records and has already been noticed in accounts of Gilbert's life. It seems worth while to identify this interesting site more closely, however, for it was in Wingfield House that the seed of modern science in England germinated and bore its first fruit.

The earliest known reference to Wingfield House is in an indenture executed in 1519[1]. It is not clear how or when the house came into Gilbert's possession, though the fact that his stepmother was a Wingfield provides a clue. However, the successive ownership of the property after Gilbert's death in 1603 can be traced through his will[2] and through various deeds of conveyance[3,4] until the time of the Great Fire of 1666, when the house was destroyed. Collation of entries in the manuscript survey of building sites in London after the Great Fire[5] with Ogilby and Morgan's map of London published in 1677 shows that Wingfield House stood opposite the northern end of the College of Arms, almost exactly in the middle of the east side of the remnant of St. Peter's Hill that runs between Knightrider Street and Queen Victoria Street.

It appears from the deeds that the front of the house was 36 ft. wide, and that the site extended back about 100 ft. Some years after Gilbert died, part of Wingfield House was sold to "the Master, Wardens and Cominalty of the Mystery or Art of Upholders"—that is, the livery company of Upholders or Upholsterers. The indenture[4] that defines the partition of the property describes the house at some length. There was a paved yard near the middle of the site between a fore part and a rear part of the building, the two parts being connected by the kitchen, which presumably flanked the yard. There was probably also another yard or garden at the back.

The eastern side of St. Peter's Hill was devastated again during the Second World War. The remains of a wall that can be seen running east from the street may well mark the northern boundary of the site of Wingfield House.

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[1] Hustings Roll, 238 (91).
[2] Prerogative Court of Canterbury, Bolein 109.
[3] Hustings Rolls, 342 (20) and 349 (52).
[4] Close Roll, C54/3341, mem. 1.
[5] Survey by Mills, P., and Oliver, J., Vol. 1, fol. 35 (b); Vol. 2, fol. 19 (a); Vol. 4, fol. 131 (a).

Cooling Bath for Cytological Investigations

THE disadvantage of liquid air[1] as a cooling bath for the rapid quenching necessary in freezing and drying for cytological purposes was recognized by Hoerr[2] as the formation of a vapour coat of low thermal conductivity around the specimen. He introduced isopentane for this purpose as a liquid of high boiling point which did not vaporize around the piece of tissue. Isopentane cannot be cooled below its melting point, — 160° C., and near this temperature is a thick liquid which cannot be stirred efficiently. In a search for a better bath liquid it has been found that propane has several advantages. It can be cooled to — 190° C. and is still very fluid near its melting point. It is easily obtainable as 'Propagas' (B.O.C.)[3]. Both isopentane and propane have to be cooled with liquid nitrogen, because of the fire and explosion hazard with liquid air or oxygen.

With the increasing use of freezing and drying by histologists and cytologists, it is of interest to report that a non-inflammable and non-toxic cooling bath can be made by condensing dichloro-difluoromethane in a tube cooled by liquid air. This material is easily obtained as 'Arcton 6' (I.C.I.) and has a melting point of — 158° C. It is denser than either of the hydrocarbons, and the pieces of tissue float on the surface after quenching, allowing easy recovery from the bath. The possible use of such a bath was discussed at the Bristol meeting of the cytochemistry commission of the International Society of Cell Biology in July 1951.

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June 27.

[1] Gersh, I., *Anat. Rec.* (U.S.A.), **53**, 309 (1932).
[2] Hoerr, N. L., *Anat. Rec.* (U.S.A.), **63**, 293 (1936).
[3] Bell, L. G. E., "Int. Rev. Cytology", **1** (New York); "Freezing and Drying" (Inst. of Biology, London).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 27

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Impact of Television on Sound Broadcasting" (to be opened by Mr. G. Parr).

CHEMICAL SOCIETY, OXFORD SECTION (in the Physical Chemistry Laboratory, South Parks Road, Oxford), at 8.15 p.m.—Prof. Alexander Haddow: "Carcinogenesis" (Alembic Club Lecture). (All Fellows are invited.)

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Capt. John Glaever and Mr. G. de Q. Robin: "International Expedition to Antarctica".

Tuesday, October 28

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Colin Smith: "Renan and Science".*

IRON AND STEEL INSTITUTE (joint meeting with the BRITISH IRON AND STEEL RESEARCH ASSOCIATION, at 4 Grosvenor Gardens, London, S.W.1), at 2 p.m.—Discussion on "The Corrosion of Steel under Phosphate Coatings and Protective Finishes".

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 2.30 p.m.—Sir Martin Roseveare: "The School and the Health of the Community".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. Bernard W. Bradford: "Physical Chemistry in the Chemical Industry". (Further Lecture on November 4.)

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. D. O. Walter: "The Design of Sliding Contact Assemblies in Instrument Applications".

Tuesday, October 28—Wednesday, October 29

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 10 a.m. each day.—Conference on "A Special Study of Ash and Clinker in Industry".

Wednesday, October 29

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Presentation of the Planck Medal to Prof. P. A. M. Dirac by Prof. M. von Laue.

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. F. J. Anscombe: "Sequential Estimation".

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. M. Cock: Chairman's Address.

Thursday, October 30

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Miss Pauline Whitby: "Animal Food".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Harold Spencer Jones, F.R.S.: The Masses of the Sun, Planets and Stars". (Further Lectures on November 6 and 13.)

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. E. W. Still: "Temperature Control for Pressure Cabin Jet Aircraft".

Friday, October 31

ROYAL METEOROLOGICAL SOCIETY, SCOTTISH CENTRE (in the Department of Natural Philosophy, The University, Drummond Street, Edinburgh), at 5 p.m.—Prof. P. A. Sheppard: "Atmospheric Turbulence and the General Circulation".

BEDSON CLUB (in Lecture Theatre I, Chemistry Building, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. C. W. Davies: "Ion Association" (87th Bedson Lecture).

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Portico Library, Mosley Street, Manchester), at 6 p.m.—Mr. R. F. H. Banister: "What Management Expects of Statisticians".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Westgate Road, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. Claude Seippel: "From Stodola to Modern Turbine Engineering" (Parsons Memorial Lecture).

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemical Laboratory, Pembroke Street, Cambridge), at 8.15 p.m.—Dr. T. C. J. Ovenston: "By-Ways in Absorption Spectrophotometry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Morris W. Travers, F.R.S.: "Sir William Ramsay".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade B) IN BIOLOGY—The Principal, Acton Technical College, High Street, Acton, London, W.3 (November 1).

RESEARCH ASSISTANT AT THE PLASTIC SURGERY CENTRE, for work in connexion with the application of radioactive isotopes to clinical research—The Group Secretary, Odstock Hospital, Salisbury (November 1).

TEACHERS OF MATHEMATICS AND PHYSICS, Iraqi Ministry of Education, Baghdad—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting subject and 'Baghdad' (November 1).

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (November 3).

CHEMIST (Scientific Officer grade) (with suitable good honours degree and, preferably, some research experience) for research on the proteins and enzymes of milk—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (November 8).

PLANT PATHOLOGISTS (with a four-year degree in botany, agricultural botany or agriculture, with at least one year's specialization in plant pathology), Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (November 8).

RESEARCH ASSISTANT (qualified in social anthropology or sociology and statistics) to engage in a community research project—The Registrar, The University, Leeds 2 (November 8).

SCIENTIST (with a good honours degree in natural science (physics, chemistry or mathematics) preferably with experience in the study of dust and other industrial environmental problems) on the staff of the Director of Scientific Control at London headquarters, to coordinate and supervise environmental studies which are to be carried out at 20 or more selected collieries during the next 10 years as part of a field research on pneumoconiosis—The National Coal Board, Establishment (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/544 (November 10).

TEXTILE SCIENTIST (Senior Research Officer or Research Officer grade) IN THE PHYSICS AND ENGINEERING UNIT of the Wool Textile Research Laboratory, Sydney, to develop a programme of research into the physical properties of fibre assemblies or into the physical principles of textile processes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 4010 (November 15).

CHAIR OF PHARMACOLOGY at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 17).

SENIOR LECTURER IN BOTANY (Plant Physiology) at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 1).

LECTURER IN CIVIL ENGINEERING at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 15).

LECTURER IN ZOOLOGY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 3).

RUTHERFORD SCHOLARSHIP for research in any branch of the natural sciences—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (February 15).

ASSISTANT (with a degree in botany or natural science and some training in plant pathology) to the Chief Officer, and a RESEARCH ASSISTANT (with a degree in botany or natural science), in the Official Seed Testing Station for England and Wales—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

ASSISTANT LECTURER IN CHEMISTRY—The Acting Registrar, University College, Exeter.

GEOLOGIST for service in the Antarctic with the Falkland Islands Dependencies Survey—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.33272.E.

HEAD OF THE DEPARTMENT OF CHEMICAL TECHNOLOGY, Indian Institute of Science, Bangalore—The Ministry of Labour and National Service (A.8.12), Almack House, 26 King Street, London, S.W.1, quoting A.12/1.31.E.

LIBRARIAN-INFORMATION OFFICER (with a science degree and, preferably, a working knowledge of French or German)—The Director, Fruit and Vegetable Canning and Quick Freezing Research Association, Campden, Glos.

PHYSICAL CHEMIST (Scientific Officer or Senior Scientific Officer grade) at a Ministry of Supply research establishment in South-West England, to lead a small group working upon a variety of research problems in physical chemistry—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.660/52A.

RESEARCH ASSISTANT IN THE DEPARTMENT OF AERONAUTICAL ENGINEERING, to aid and initiate researches in the study of noise from aircraft and jets—The Registrar, The University, Southampton.

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER, for an investigation on the soundness of iron castings—The British Cast Iron Research Association, Alvechurch, Birmingham.

SENIOR PLANT PATHOLOGIST (with a good honours degree and considerable postgraduate research experience of virus diseases of trees and, if possible, of handling insect vectors) at the West African Cocoa Research Institute, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 63/86/01.

SENIOR SCIENTIFIC OFFICER for chemical and technical investigations of plant and animal products, and assistance in preparation of memoranda, reports and replies to inquiries regarding their production, preparation and marketing (Ref. F. 666/52A), and a SCIENTIFIC OFFICER to assist in the duties outlined above (Ref. F. 667/52A), at the Colonial Products Advisory Bureau (Plant and Animal), London, S.W.7—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

UNIVERSITY GRADUATE OR POSTGRADUATE IN ELECTRICAL OR MECHANICAL ENGINEERING, PHYSICS OR MATHEMATICS (with at least three years experience in the application and use of gyroscopes in navigational instruments and the development of low wander rate gyros)—The National Research Council of Canada, Africa House, Kingsway, London, W.C.2, quoting Ref. No. 2908.